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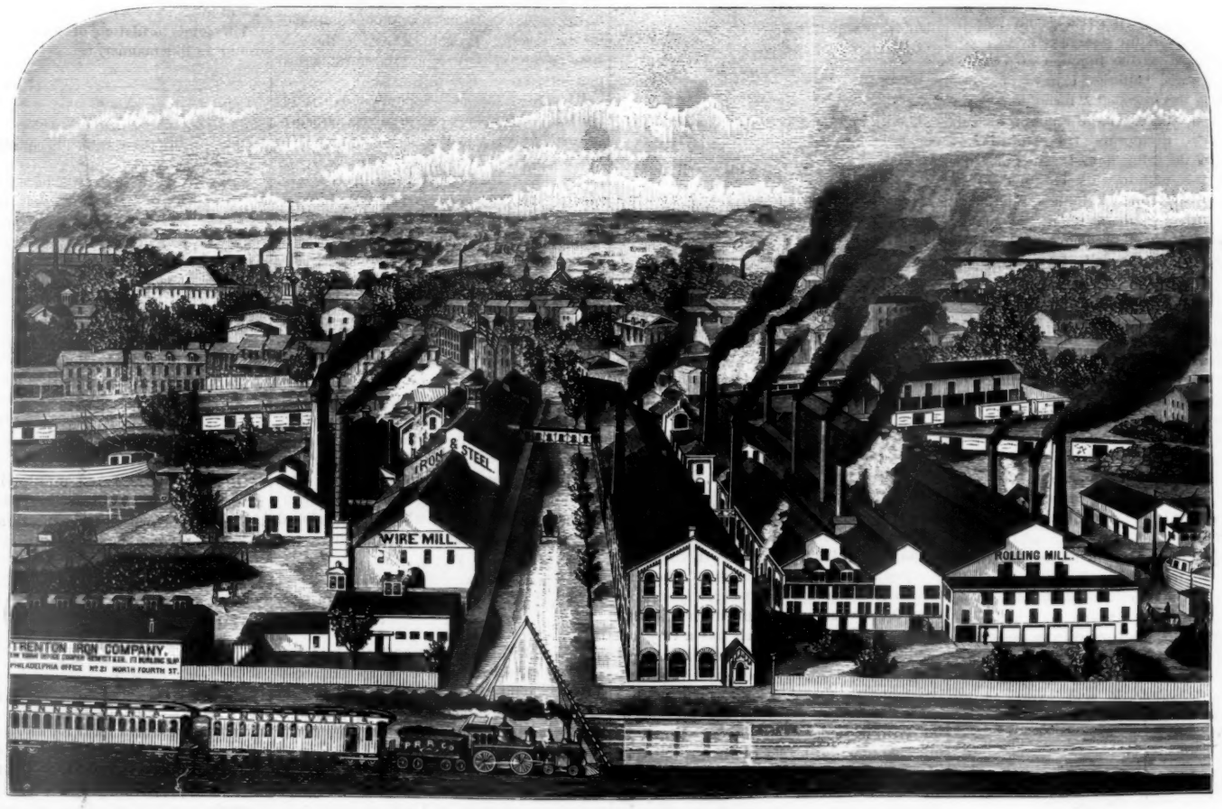
Works of the Trenton Iron Company.

A description of these works will be of interest to our readers at this time, because of the recent death of the founder, Mr. Peter Cooper, who was so conspicuously interested in this large wire mill in its earlier history.

Beginning in a meager way about forty years ago, the enterprise has grown, under careful management, until it stands among the foremost manufactories of wire in this country—supplying a large and increasing trade with a good quality of wire of various sizes (chiefly charcoal iron), and including such as are suitable for all telegraphic and telephonic purposes.



WORKS OF THE TRENTON IRON COMPANY.

The mills are conveniently situated on the Delaware and Raritan Canal basins, from which run within the factory enclosure. Pig and scrap iron and steel from the various sections in New Jersey and Pennsylvani are shipped in barges direct to the mills without extra handling. So, likewise, is the metal sent by railroad, which, like the canal, empties its thousands of tons per year into the yards, where it is assorted, and soon afterwards goes to the furnace.

The scrap iron, from which the charcoal iron wire is made, after undergoing a careful examination, is carried to the forge fires, twelve of which are located in the rolling-mill building. Into these furnaces the metal and charcoal are placed. The heat necessary to reduce the iron into a soft, malleable mass is regulated by a blast, which requires some skill to manipulate. This red-hot lump of iron, mixed with cinder, is called a loup, and when in a soft, molten state is taken from the furnace with tongs, and carried upon a rolling iron frame to the steam hammer, where it is worked down and cut into two blooms about five inches square, and weighing about 125 lbs each.

These blooms are then re-heated in a reverberatory heating furnace, re-hammered and rolled in a 20-inch train into bars or billets of the required size, usually 1¼ inch square and 6 or 7 feet long. The billets are next rolled into wire rods in one of the rod-trains, of which there are two, viz.: one 10-inch and one 8 inch. This completes the hot working of the iron; the subsequent "drawing" is an entirely different operation. The wire rods are now taken into the "wire mills," and drawn by modern appliances into various sized wire from three-quarters of an inch in diameter to the finest possible thickness, known in the trade as No. 45, the latter scarcely larger than a hair. This part of the mill is divided into two distinctive departments, one for the working and finishing of the larger sizes of wire, and the other for the finer and more delicate grades. In the former department, which occupies the ground floor of the center buildings, there are about sixty "blocks" (as the cylinders on which the wire is drawn are technically called.)

In the loft above the main floor in these buildings the wire finer than No. 18 is made here this concern have 900 "blocks" in charge of some fifty skilled men, turning out hundreds of miles of wire of the finest quality. In this department the Edison light is used as an illuminant when running at night, as is frequently the case with this enterprising house.

In other departments the winding, testing, and packing and shipping goes on without jar or delay.

The galvanizing and tinning works are almost perfect in their appliances for properly taking care of this important part of the work.

The acid used in cleaning the wire after repeated use is converted into an article of merchandise by boiling and evaporating until it becomes copperas.

The power to drive these mills is taken from six principal engines, besides a large number of small ones. Of these six, three were built by Corliss, one by Wright of Newburgh, N. Y., one by the Phœnix Iron Works of Trenton, and one high speed engine of the Porter-Allen pattern, by the Southwark Foundry of Philadelphia.

There are eleven acres of land within the enclosure, of which six are covered by buildings. Five hundred and fifty men are employed in this vast business.

The officers of the company are: President, Hon. Abram S. Hewitt, of New York; Vice-President, Mr. Wm. Hewitt, M. E., (a son of the late esteemed President of the Company, the Hon. Charles Hewitt of Trenton); Treasurer, Mr. James Hall; Secretary, Mr. E. Hanson. The headquarters of the President and Treasurer are at the offices of Cooper, Hewitt & Co., 17 Burling Slip, New York; the Vice-President and Sccretary are located in Trenton.

The company has a branch office and warehouse at 21 N. Fourth street, Philadelphia, which is in charge of Mr. John Hewitt.

"Contributions to the Chemistry of Storage Batteries."

BY E. FRANKLAND, D. C. L., F. R. S.

1. *Chemical Reactions.*—The chemical changes occurring during the charging and discharging of storage batteries have been the subject of considerable difference of opinion amongst chemists and physicists, Some writers believe that much of the storage effect depends upon the occlusion of oxygen and hydrogen gases by the positive and negative plates or by the active material thereon, some contend that lead sulphate plays an important part, whilst others

assert that no chemical change of this sulphate occurs either in the charging or discharging of the plates.

To test the first of these opinions, I made two plates of strips of thin lead twisted into corkscrew form, and after filling the gutter of the screw with minium, so as to form a cylinder that could be afterwards introducod into a piece of combustion-tubing, these plates were immersed in dilute sulphuric acid and charged by the dynamo-current in the usual manner. The charging was continued until the whole of the minium on the + and — plates respectively was converted into lead peroxide and spongy lead, and until gas bubbles streamed from the pores of the two cylinders.

After removal from the acid the plates were superficially dried by filter-paper, and immediately introduced into separate pieces of combustion-tubing previously drawn out at one end, so as to form gas delivery tubes. The wide ends of these tubes were then sealed before the blow-pipe, care being taken not to allow the heat to reach the enclosed cylinders. The tube containing the cylinder of reduced lead was now gradually heated until the lead melted, the drawn-out end of the tube meanwhile dipping into a pneumatic trough. The gas expelled from the tube consisted almost exclusively of the expanded air of the tube and contained mere traces of hydrogen.

The tube containing the cylinder of lead peroxide was similarly treated, except that the heat was not carried high enough to decompose the peroxide. Mere traces, if any, of occluded oxygen were evolved.

These results justify the conclusion that occluded gases play, practically, no part in the phenomena of the storage cell.

With regard to the function of lead sulphur in storage batteries, I have observed that during the so-called "formation" of a storage cell, a very large amount of sulphuric acid disappears from the liquid contents of the cell; indeed, sometimes the whole of it is withdrawn. The acid so removed must be employed in the formation of insoluble lead sulphate upon the plates, which, in fact, soon become coated with a white deposit of the salt, formed equally upon both positive and negative surfaces. This visible deposit is, however, very superficial, and does not account for more than a very small fraction of the acid which actually disappears from solution. The great bulk of the lead sulphate cannot be discovered by the eye, owing to its admixture with chocolate-coloured lead peroxide.

Unless the coated plates have been previously immersed for several days in dilute sulphuric acid, this disappearance of acid during their "formation" continues for ten or twelve days. At length, however, as the charging goes on, the strength of the acid ceases to diminish and soon afterwards begins to augment. The increase continues until the maximum charge has been reached and abundance of oxygen and hydrogen gases begin to be discharged from the plates; that is to say, until the current is occupied exclusively, or nearly so, in the electrolysis of hexabasic sulphuric acid expressed by Burgoin in the following quation:

$$\underset{\text{Sulphuric acid.}}{SO_6H_6} = \overbrace{\underset{\text{Sulphuric anhydride.}}{SO_3} + 3O}^{\substack{\text{Eliminated}\\ \text{on + plate.}}} + \overset{\substack{\text{Eliminated}\\ \text{on — plate.}}}{3H_2}.$$

Of course, the sulphuric anhydride immediately combines with water and regenerates hexabasic sulphuric acid:—

$$SO_3+3OH_2=SO_6H_6.$$

On discharging the cell, the specific gravity of the acid continually decreases until the discharge is finished, when it is found to have sunk to about the same point from which it began to increase during the charging. Hence is is evident that, during the discharge, the lead sulphate, which was continuously decomposed in charging, was continuously reformed in discharging.

The chief, if not the only, chemical changes occurring during the charging of a storage battery, therefore, appear to be the following:

1st. The electrolysis of hexabasic sulphuric acid according to the equation already given.

2d. The reconversion of sulphuric anhydride into sulphuric acid.

3d. The chemical action on the coating of the + plate:—

$$\underset{\text{Lead sulphate.}}{SO_4Pb} + O + 3OH_2 = \underset{\substack{\text{Lead peroxide.}\\ \text{Hexabasic}\\ \text{sulphuric acid.}}}{PbO_2 + SO_6H_6}.$$

4th. The chemical action on the coating of the negative plate:—

$$\underset{\text{Lead sulphate.}}{SO_4Pb} + H_2 + 2OH_2 = Pb + \underset{\substack{\text{Hexabasic}\\ \text{sulphuric acid.}}}{SO_6H_6}.$$

If I have correctly described these changes, the initial action in the charging of a storage cell is the electrolysis of hexabasic sulphuric acid, each molecule of which throws upon the positive plate three atoms of oxygen, and upon the negative plate six atoms or three molecules of hydrogen. Each atom of oxygen decomposes one molecule of lead sulphate on the positive plate, producing one molecule of lead peroxide, and one of sulphuric anhydride, the latter instantly uniting with three molecules of water to form hexabasic sulphuric acid.

The following are the chemical changes which I conceive to occur during the discharge of a storage cell:—

1st. The electrolysis of hexabasic sulphuric acid as in charging.

2nd. The reconversion of sulphuric anhydride into hexabasic sulphuric acid as already described.

3rd. The chemical action upon the coating of what was before the positive plate or electrode, but which now becomes the negative plate of the cell—that is to say, the plate from which the positive current issues to the external circuit:

$$\underset{\text{Lead peroxide.}}{PbO_2} + \underset{}{H_2} = \underset{\text{Lead oxide.}}{PbO} + \underset{\text{Water.}}{OH_2}$$

The lead oxide thus formed is immediately converted into lead sulphate:—

$$PbO+SO_6H_6=SO_4Pb+3OH_2.$$

4th. The chemical action upon the coating of what has now become the positive plate of the cell:

$$Pb+O+SO_6H_6=SO_4Pb+3OH_2.$$

Thus in discharging, as in charging, a storage cell, the initial action is the electrolysis of hexabasic sulphuric acid. The oxygen eliminated on the positive plate reconverts the reduced metal of that plate into lead oxide, whilst the hydrogen transforms the lead peroxide on the negative plate into the same oxide, which in both cases is immediately converted into lead sulphate by the surrounding sulphuric acid, thus restoring both plates to their original condition before the charging began.

The real "formation" of the cell consists, I conceive, in the more or less thorough decomposition of those portions of the lead sulphate which are comparatively remote from the conducting metallic nucleus of the plate. Lead sulphate itself has a very low conductivity, whilst lead peroxide, and especially spongy lead, offer comparatively little resistance to the current, which is thus enabled to bring the outlaying portions of the coating under its influence. It may be objected that, during the discharge, the work of formation would be undone; but, probably, in the ordinary use of a storage battery, the discharge is never completed. Thus, I have found that, in a small cell containing two plates, 6″×2″, short-circuiting with a thick copper wire for twelve hours was far from producing complete discharge, for, on breaking this short circuit, the cell *instantly* rang violently an electric bell with which it was previously connected. In ordinary discharges of "formed" cells, therefore, the lead sulphate on the positive and negative plates still remains mixed with sufficient lead oxide and spongy lead, respectively, to give it a higher conducting power than the sulphate alone possesses.

2. *Chemical Estimation of the Charge in a Storage Cell.*—No method has hitherto been known by which the charge in a storage cell could be ascertained without discharging the cell; but the results of the foregoing experiments indicate a very simple means of ascertaining the amount of stored energy without any interference with the charge itself. The specific gravity and consequent strength of the dilute sulphuric acid of a "formed" cell being known in its uncharged and also in its fully charged condition, it is only necessary to take the specific gravity of the acid at any time in order to ascertain the proportion of its full charge which the cell contains at that moment; and if the duty of the cell is known, the amount of energy stored will also be thereby indicated. In the case of the cell with which I have experimented, containing about seven quarts of dilute sulphuric acid, each increase of .005 in the specific gravity of the dilute acid means a storage of energy equal to 20 ampères of current for one hour, obtainable on discharge.

I hope shortly to be able to express, in terms of current from the cell, the definite relation between the amount of energy stored and the weight of sulphuric acid liberated.

On a Simple Formula for Determining the Insulation of a Section of Wire Measured through an Intermediate Lead.

By G. A. Hamilton.

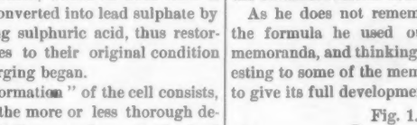
It frequently happens when the insulation resistance of a section of line, an underground wire or cable is wanted, that various impediments prevent reliable measurements from being made at either terminal of the same. At a cable-house it may be the wind or the jar resulting from passing trains along a railroad, the bumping of a ferry-boat against the dock or the inductive disturbance due to motion of its machinery; or, again, it may be the constant passing of trains along the elevated road that interferes.

In some of the cases enumerated it is undoubtedly possible to obtain correct measurements if time is a matter of no consequence, but when it is an important factor the delays and incident annoyances make the measurement of 10, 20 or more conductors anything but a pleasant occupation.

Having experienced all these troubles in and around New York, the writer has made it a practice, in all cases where approximate accuracy is desired, to adopt the old plan of measuring the insulation through a lead of such length as convenience or the circumstances of the case will permit and at the same time allow of placing the galvanometer where its indications may be depended upon. The resistance sought is then deduced from the combined results obtained.

As he does not remember of having seen the formula he used outside of his own memoranda, and thinking it may prove interesting to some of the members, he is induced to give its full development herewith:

Fig. 1.



Let *A B* (Fig. 1) represent the lead and *B C* the conductor, whose insulation resistance is sought, the conductor resistance in each case being a *small fraction* of the insulation resistance, which latter may be represented by y and x respectively.

Under these circumstances, with *A B* and *B C* joined and the end at *C* insulated, measurements made at *A* will give the joint insulation of the two conductors, which we will designate by z. Then

$$z = \frac{\times y}{x+y}$$

and the insulation sought will consequently be

$$x = \frac{y\ z}{y-z} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

As x, y and z are usually high, measurements by the bridge method are not often practicable, and a mirror, or other galvanometer whose deflections are proportional to the current circulating in its coils, is then generally employed. When this is the case the constant of the instrument must be known. This is obtained in the well-known manner by ascertaining what deflection it gives through a known resistance with a given battery. The resistance sought is then found by placing the same instrument and battery in circuit with it, noting the corresponding deflection and dividing the constant previously obtained by the latter deflection. The quotient is the resistance sought in ohms, or megohms, as the case may be.

In using this method for determining the insulation of a section of a line through a lead many persons would naturally take the roundabout way of finding the resistance of the lead, and joint resistance of lead and section tested separately, and then combine the results as in formula 1.

If, however, the combination is first effected the resulting formula gives the required insulation with very little calculation. This is the plan the writer finds most convenient to practice:

Let a represent the constant of the instrument, *i. e.*, the resistance through which, with a given battery, it will give 1° deflection; d, the deflection obtained when the lead, instrument and battery are in circuit; D, the deflection, when the lead, instrument, battery and section whose insulation is wanted are in circuit.

The insulation of the lead would then be

$$y = \frac{a}{d}$$

or, if reverse currents are used, as is proper,

$$y = \frac{a}{\frac{\Sigma \pm d^2}{2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where Σ is a symbol only and indicates that the sum of the + and — deflections are to be taken.

The joint insulation of lead and section would, in like manner, be

$$z = \frac{a}{\frac{\Sigma \pm d^2}{2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Substituting these values in equation (1) we have

$$X = \frac{\frac{a}{\frac{\Sigma \pm d^2}{2}} \times \frac{a}{\frac{\Sigma \pm d^2}{2}}}{\frac{a}{\frac{\Sigma \pm d^2}{2}} - \frac{a}{\frac{\Sigma \pm D^2}{2}}} = \frac{\frac{4\,A^2}{\Sigma (\pm d^2 \times \Sigma \pm D^2)}}{\frac{2\,A}{\Sigma \pm d^2} - \frac{2\,A}{\Sigma \pm D^2}} \quad \ldots\ldots\ldots\ldots (4)$$

Dividing by 2 A and multiplying (both numerator and denominator) by $\Sigma(\pm d \times \pm D)$ the resulting equation takes the form

$$X = \frac{2\,a\,\Sigma(\pm d^2 \times \pm D^2)}{\Sigma(\pm d \times \pm D)\left\{\Sigma\left(\frac{\pm d^2 \times \pm D^2}{\pm d^2}\right) - \Sigma\left(\frac{\pm d^2 \pm D^2}{\pm D^2}\right)\right\}}$$

which on cancellation of common factors becomes

$$X = \frac{2\,A}{\Sigma(\pm d^2 - \pm D^2)} \quad \ldots\ldots\ldots\ldots (5)$$

the most convenient form for use.

In the foregoing illustration, a single + and — reading only are taken, if more are used the same should properly appear in the formula, and it is, of course, necessary that a like number of readings should be taken for the lead (whether they do or do not vary), as is taken in the joint measurements.

It will also be understood that when shunts are used they should be accounted for in the formula, as for instance,

$$X = \frac{2\,A}{\Sigma \pm (D^2 \text{ X shunt} - \pm d^2 \text{ X shunt})}$$

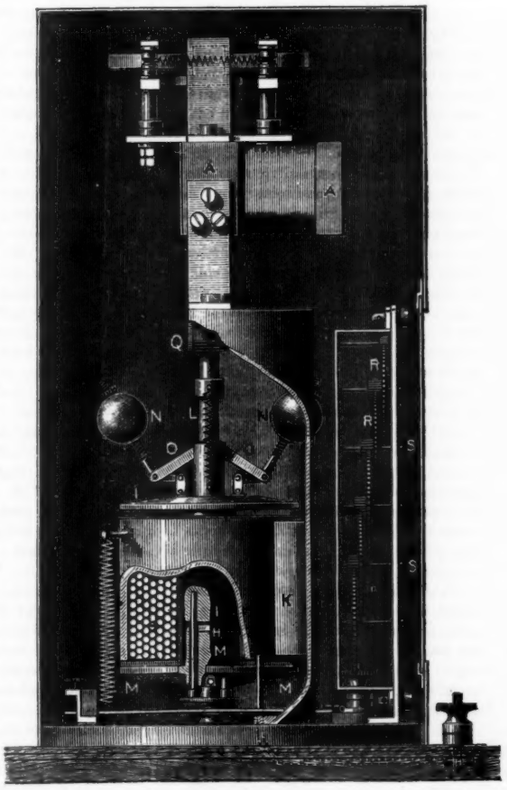
This is supposed to have been done for A at first.

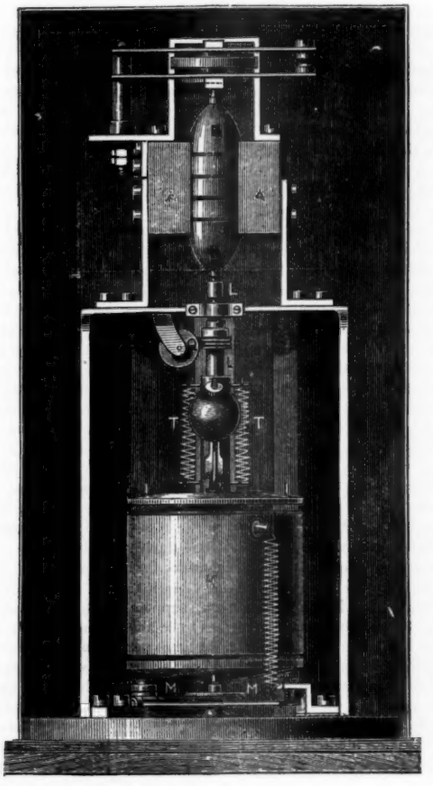
At Philadelphia on the 28th ult., Judge Allison granted a temporary injunction restraining the Maxim Electric Light and Power Company from erecting poles and operating wires on the west side of Delaware avenue, between Vine and South streets.

Dr. Hopkinson's Improved Current Meter.

Electric current meters of various forms have been tried and found imperfect, and upon this particular piece of electrical mechanism much ingenuity and time have been spent. In the illustration herewith given will be found one of the best meters, in many respects, which has so far come to our notice.

The question of measuring the electric supply to a house or factory is becoming of serious importance, as may be gathered from the animated discussion which took place after the reading of Mr. Shoolbred's paper on the subject at the recent meeting of the Society of Telegraph Engineers and Electricians. Electric meters may be divided into two classes: (1) Quantity or Coulomb meters, and (2) energy or work meters. The first class is that which is in favor with the public, who regard the electric current much in the same way as they regard water supply, and do not understand that the proper analogy to it is *water under pressure*, not simply water in quantity. As Professor Perry pointed out at the meeting referred to, the energy or erg-meter is really the proper instrument to use, since it is electric energy which is supplied; and if, as appears likely, the current is made to perform mechanical work in addition to lighting a building, the necessity for an energy or work-meter becomes still more obvious. In New York the Edison system is at work in a large district, and it is stated that the chief revenue of the supplying company is for electric power delivered to machines by day The light, in fact, given at night is regarded as a "waste product," just as coke, ammonia and tar are regarded by the gas companies. On the whole, then, it appears that for the manufacturers' sake it would be best if energy meters were adopted in preference to Coulomb or quantity meters. But, according to Mr. R. T. Crompton, this is unlikely to happen, as the Board of Trade have evidently made up their minds to have current meters.





The current meters of Edison and Sprague are based on electrolytic action—that is to say, the deposition of zinc or copper by the passage of a portion of the current through an electrolytic cell. The portion of current thus employed bears a constant ratio to the whole current, and hence the weight of metal deposited in a given time measures the quantity of current. In Sprague's pattern the current is periodically reversed through the cell by automatic action, and the work done is thus undone again, and the number of reversals is recorded in a given time as a measure of the current. Messrs. Ayrton and Perry, Mr. Boys, and others have devised very ingenious current meters based on electro-magnetic and mechanical effects. To this class belongs the current meter of Dr. J. Hopkinson, F.R.S., which we now illustrate, and which has many advantages in its favor.

Fig. 1 is a side view, with part shown in section, of the Hopkinson Coulomb or current meter, and Fig. 2 is a back view, with case shown in section. In both figures *a*, *a* are the electro-magnets of a small dynamo-electric machine to be used as a motor, *b* being its armature. This dynamo is wound with fine wire as a shunt to the current to be measured, part of which passes from *L* round the electro-magnets, then through the armature, and thence by brushes and wire to the insulated ring *h* (Fig. 1). Here the circuit may be either made or broken, according as the movable piece or core *i*, is raised or lowered. If this piece, which is a soft iron core within a solenoid, be lowered, the circuit is completed to the metal frame of the instrument through a vertical contact pin *p*. This pin projects into a groove in the core, and forms a rubbing contact as the latter revolves.

The current to be measured passes through a solenoid of stout wire *j*, inclosed in an iron tube *k*, supported by the frame of the instrument. The vertical shaft *l*, is driven by the armature of the dynamo, and carries the iron core, *m*, *m*, fixed to it. The iron core *i*, revolves with the shaft *l*, and can slide upon it. It is connected by links, *o*, *o*, to the governor balls, *n*, *n*, which therefore tend to raise it as the shaft revolves. The revolutions of the shaft are indicated by the worm and worm-wheel *q*, acting on the shaft and operating the pinions, *r*, *r*, and hands of the counter *s*. Springs *t*, take the weight of the core *i*, and are so adjusted that when no current passes through the coil *j*, contact is broken with the insulated ring *h*; but a very small current through this coil will make the contact and cause the electromotor to begin to revolve. When a current passes through the coil *j*, it causes attraction between the fixed tube *k*, and the flanges of the moving cores *m* and *i*, also between the cores *m* and *i*. The magnetic force upon *i* is vertically downwards, and is proportional, within certain limits, to the square of the current in the coil. When the governor is revolving, the centrifugal force on the governor balls is proportional to the square of the speed of revolution, and tends to lift the core *i*, in opposition to the magnetic force. These forces will exactly balance one another, for if the speed be too great, the circuit of the electromotor will be broken, and the speed will fall. If it be too small, the electromotor will work, and the speed will increase. The result is that the system will revolve with a velocity proportional to the current through the coil. Owing to the symmetrical arrangement of the cores, the electro-magnetic forces are balanced, as far as the shaft *l* is concerned, and they do not tend to put any pressure upon the bearings.

Heat, Light and Electricity; Are They Expressions of the Same Force?

By Prof. Elisha Gray.

In the short time allotted me for discussing a subject so vast as the one before us to-night, it will be impossible to give it more than a cursory presentation. It is one that has puzzled many older, and, I was about to say, wiser heads than ours of this generation; but I am not one of those who believe that wisdom died with the old philosophers, and that we are simply echoes of a past age. They *were* great men in their time, and towered high above the rank and file of their generation; but we can imagine that even Newton, with his emission theory of light, or Franklin, with his fluid theory of electricity, would either of them cut but a sorry figure among the thinking scientific men of to-day. In this age of lightning, steam, and printing, of school-houses and school-teachers, of reading and travel: this age when all the world are within speaking distance of each other, the man who outstrips his neighbor must be something more than a mere echo.

But to our subject: We have to deal to-night with what are called imponderable forces or energies of nature—heat, light, and electricity. What relation do they bear to each other? Are they expressions of the same force? I confess to having a strong feeling in favor of the affirmative side of the question; a feeling that has grown stronger with each year of study upon this and kindred subjects, until from my standpoint it has ceased to be a speculative question. But now comes the most difficult part of my task. It is easy, perhaps, for us to see from our own standpoint, but how can we make others take the same view that we do? To do this we must first give him the same experience, the same surroundings, the same opportunities, and he must have the same characteristics or qualities of mind. There is a vast amount of unexplainable evidence that presents itself to the mind of the individual, but this he cannot submit to a jury outside of himself. When, however, he makes up his case, he puts this intangible, so to speak, beside the tangible and renders his verdict from the sum of all kinds of evidence before him. We must content ourselves then with presenting a few of the most striking evidences of the correlation of these forces.

First, we must have a clear idea in our minds of the definition of force. What is it? Faraday defines it as "the cause of a physical action; the source or sources of all possible changes among the particles or materials of the universe."

Some writers call it energy and class it under two heads, energy of motion and energy of position; or, as Clerk Maxwell calls it, kinetic energy and potential energy. The bent bow is an example of energy at rest or potential energy; but when the string is released it becomes kinetic or moving energy, and sends the arrow into the target. A weight, when elevated, possesses potential energy; but when released this immediately becomes kinetic or moving energy during its passage to the earth. A lump of coal possesses energy at rest; but when we put it under the boiler of a locomotive, and apply the match, this sleeping energy is aroused and a railroad train is sent flying across the continent.

Energy or force is again subdivided into mechanical, molecular and radiant energy. Our subject to-night deals more especially with the two latter forms. By mechanical is meant a movement of the mass, as the turning of wheels or movement of anything, or that which *tends* to the movement of any material thing as a whole, however small, so long as we consider it a movement of a mass of atoms and not of the atoms or molecules themselves independently.

By molecular energy we mean the movement of the molecules of which the mass is made up—movements that are independent of the mass.

In a former lecture, to give a conception of the difference between molecular and mechanical motion, I used the following illustration: "Some of you may have seen a new swarm of bees as they go out of the old hive to seek a new home. They will light on some object near the old hive, perhaps the limb of a tree. Instead of spreading themselves around over a large surface, they will light one upon another until they have formed a mass of bees as large as a cannon ball. Looking at this mass as a whole, it seems to be quiet, but if you examine it closely you can see that each individual bee is in motion. This individual motion will represent the molecular motion of the mass. Now, suppose these bees to be so small that it would require fifty millions of them ranged in single file to occupy the space of a linear inch. Then let us get together enough of them to make a mass as large as a cannon ball, and we have some conception of molecular motion as distinguished from mechanical or visible motion. But you ask, How can these molecules move when they are bound together? The theory is that all space is filled with a very subtle form of matter, called ether. It is everywhere present and pervades all masses of matter, even the most solid. It surrounds every molecule and every atom in the universe, so that all the countless worlds are afloat in this subtle fluid, not only as masses, but as molecules and atoms of which they are made up. No one of these actually touches the other, but is surrounded by the subtle fluid, so that

each atom and molecule has its own little orbit of motion."

Having described the difference between mechanical and molecular, let us now consider the last of the trio, and ask, what is radiant energy? I have alluded to the theory of the existence of an ether, so subtile that it prevades all space, even the intersellar spaces surrounding the molecules of all masses of matter. I here use the word space and matter in the ordinary sense; for, considering the hypothetical ether to be a very elastic form of matter without sensible weight, there is no such thing as space or vacuum. Although we may expel all the coarser or sensible forms of matter, and make what is commonly called a vacuum, we cannot expel the ether. We are in the dilemma of the man who invented the universal solvent. He did not dare to make any of it, because, being an universal solvent, of course nothing would hold it.

You may ask, why is it necessary to assume that there is such a fluid as an ether? Because we cannot separate energy from matter. We cannot conceive of force acting upon nothing. We cannot conceive of motion without something to move. Assuming for the moment that heat and light are modes of motion, we must admit that there exists in the vast space between us and the sun some medium through which the vibrations of heat, light and other forms of force are transmitted, for it is proved that, at most, the atmospheric envelope surrounding the earth is only a few miles deep. The so-called forces, such as light, magnetism and radiant heat are transmitted through this subtile fluid which for want of a better name we call ether. Force thus transmitted is called radiant energy.

Great confusion often arises from the misuse of words. We say heat is force, and that heat is a mode of motion. In other words, we say force is motion. Now, motion is simply a change of position of a material substance. It may be the atom or it may be the mass. Force is the cause of that change. We cannot conceive of motion existing independent of force, but we can conceive of force without motion in the form of potential energy.

If a weight is suspended by a cord, there is a force tending to break the cord equal to that required to elevate the weight. And the moment the resisting force of the cord is overcome that force produces motion. Matter is wholly inert and has no inherent power to move. I am aware that there is difference of opinion on this point, but I fail so far to see any evidence of an inherent power in the atoms of matter to move. What, then, is force? As we said before, it is the ability or the tendency to produce motion in matter, or to do work. Where does this ability come from? This question is quite as easily answered as how the atoms became possessed—if they were possessed—with an inherent ability to move. But who can answer either question?

We know that force exists, and its effect upon material substances differs greatly under different circumstances.

After all, is there more than one force? We speak of the forces of nature, and classify them as heat force, light force, electric force, etc. Should we not speak of the force of nature as exhibited in heat, in light, in electricity, etc.? You ask, if there is but one force, why does it not always manifest itself in the same way? Simply because the conditions are different at different times and in different places. The same force applied to different materials produces different results. If I apply a red-hot iron to my finger, I blister the flesh and cause great bodily pain; but if I apply the same heated iron to the face of a thermo electric pile, I produce no mechanical injury to it, but I do set up a current of electricity which will be able to give mechanical motion to the armature or needle of an electro-magnetic instrument placed in its circuit. Again, I apply the same red-hot iron to a loaded cannon, the powder ignites, and the ball is sent whizzing through the air. Now, all of these effects were the result of applying the same force in the form of heat to different materials. In one case it made a blister attended with pain, in another it created a current of electricity, and in a third it fired a cannon. I have here some mounted tuning forks. Two of them are made as nearly alike as possible. I place them some distance apart, and apply mechanical force to one of them by drawing this bow across it until it is thrown into violent vibration. These vibrations move all the air in the room, and not only the air, but all the furniture, and even the walls. The tympanic membranes of all your ears are thrown into sympathetic vibration, which is communicated to the brain through the auditory nerve, and you say that you hear a musical tone. I now check the vibrations of the fork that had the force applied to it, but you still hear the tone. The other fork has taken up the vibrations from the air and prolongs the tone. Here is still another fork in all respects like the other two, only in the matter of size and weight. I apply the same force in the same manner, and you have the result; you hear again a musical tone, but you say it is different. I stop it, but the tone is not prolonged as before by the other fork. Why? In the first instance, the forks were tuned alike, and each was only able to vibrate, as a whole, three hundred and forty-one times per second. They being in exact accord, the vibrations set up in the air by the initial fork were able to cause the other to vibrate in unison with it. The last fork had the same force applied and in the same manner, but, as you have observed, the result is different. This fork is shorter and lighter, and by a fundamental law of matter is able thereby to vibrate at a much higher rate of speed, producing a tone of higher pitch.

This statement may seem to conflict with what I have said about all the furniture in the room vibrating when the forks were sounded. All solid bodies have two kinds of vibration. When a body vibrates as a whole, we call that its fundamental or natural rate; but it may break into nodes or neutral points and vibrate in parts; hence, the vibration imparted to the furniture and walls is a species of molecular vibration. The fundamental vibration of a body is excited only when a vibration exists exactly in accord with its own rate. It will be seen that it is not necessary to conclude that every different expression of force proceeds from a different cause; it seems to me not only not necessary, but unphilosophical.

Let us consider for a moment force as expressed in vibration. To go back to the tuning fork, suppose we have one so long and large as to be able to vibrate only at the rate of eight times per second. These vibrations would be so slow and sluggish as to be seen by the eye, but not heard by the ear. Now take a smaller one. That has a fundamental rate of thirty-two vibrations per second. The eye will scarcely be able to see them, but the ear will hear them as a very low bass note. From this point, we make our forks smaller and smaller through the whole range of tones up to about forty thousand per second, where the vibrations cease to make an impression as sound. Here we pass from what we have styled mechanical to molecular vibration. We have increased the rapidity of the vibrations until the ear can no longer hear it as sound. But the vibrations now appeal to another sense—that of feeling.

Suppose we take a metal rod and apply force to it by striking a few blows on the end with a hammer. The result of the blow is a violent vibration of the atoms set up in the rod, and we have molecular vibration, and it manifests itself in the form of heat. This kind of motion does not affect the sense of hearing. In the case of the tuning fork, the brain receives the sensation of sound through the medium of the auditory nerve. In the case of the metal rod, the brain receives the sensation of *heat* through the nerves of sensation. Both of these sensations are the result of the application of the same force. Both sensations proceed from vibrations differing in rapidity. They may or may not differ in form. Let us now stimulate this molecular excitement by the application of additional force, either mechanical, electrical, or heat force. When the atoms have reached a certain stage of vibratory action, they become incandescent, and emit luminous rays of force in the form of light. This vibration is so rapid that it cannot be propagated by ordinary matter. It is not sufficiently elastic to carry vibrations that travel at the rate of one hundred and eighty-eight thousand miles per second, and here we fall back upon the before-mentioned hypothetical ether as a medium for light transmission. This ether is capable of transmitting vibrations that differ greatly in rate. For instance, the color of the lowest pitch, as shown by the spectrum, is deep red; its vibration frequency is 400 million million times per second, and its wave length in air is seven hundred and sixty millionths of a millimeter. Further down the spectrum, after the lines have ceased to be luminous, we find heat vibrations of a much less number per second. The color of highest pitch is violet, which is the highest line of light in the spectrum. This has a vibration frequency of about seven hundred and sixty million millions per second, and a wave length of four hundred millions of a millimeter.

Color, then, like sound, is, considered subjectively, a sensation produced upon the brain by rapid vibrations impinging upon the retina of the eye. The difference of color is caused by difference of rate precisely analogous to difference of pitch in musical tones, and there is about an octave of colors. The range of vision is not so great as that of hearing. The range of vision and of hearing differ greatly in different individuals. Some persons are color-blind, and some cannot hear tones as high in the scale as others. In the former case there is a defect in the retina or optic nerve, so that it is incapable of transmitting the vibrations of a particular color to the brain, and in the latter there is a defect in the auditory apparatus. The force may exist, but the machinery is defective and will not respond to it.

If we take a strip of steel and polish it so highly that it becomes a perfect reflector, it will have a white appearance, because it reflects all the colors equally. Now, if we cut fine scratches in it, too fine to be detected by the sense of touch, there will first appear a violet band of color, corresponding to the top or most refrangible line of the spectrum. Besides this band let us cut another series of lines, a little deeper. When the length of the scratches corresponds to the wave length of the vibration which causes the sensation of blue, that color will be reflected to the exclusion of the other. Going on down the scale and cutting lines a little deeper for each band of light, we bring out all the colors of the rainbow. What have we done? We have simply cut a series of fine lines across the metal strip, the depths of which correspond to the wave lengths of the color vibrations, so that they are only able to reflect the vibrations whose length corresponds to their depth.

We see all objects, except those that are self-luminous, by reflected light.

The color of an object is determined by the shape of its surface. A piece of white cloth reflects all the colors about equally; the resultant effect upon the brain is white. If we dye that piece of cloth violet, what have we done? We have saturated the cloth with a pigment whose surface structure has indentations four hundred millionths of a millimeter in depth, so that it is able only to reflect the vibration causing the sensation of violet upon the brain. All the other rays are absorbed by the cloth and appear as heat. The other colors are brought out in the same way, so that objects of different colors differ simply in their surface structure. Different tints of color, like sound tints, or quality, are obtained by the mixture of the different rates of vibrations in different proportions, as they are reflected from the object to the eye. In other words, it is the ability of the object, owing to its surface structure, to reflect to a greater or less degree any combination, or all, of the color vibrations.

Newton's theory of light was an emanation of very fine luminous material. In the light of the present day this theory has so many objections that it seems hardly worth while to spend time to combat it. Yet there are some writers of very recent date who have gone back to this theory, both as regards light and sound. It is easily proved that sound depends for a medium of transmission upon some ponderable substance of considerable density. If we put a ringing bell under an exhauted receiver, the sound ceases, but as soon as we admit the air, it becomes audible. If it contained the elements of propagation within itself, the removal of air ought to facilitate its transmission. Owing to the fact, however, that our so-called vacuum is still filled with ether, the removal of air does not interfere with the transmission of light, heat, or magnetism. The well-known incandescent electric lamp shines through a *vacuum*, so far as air is concerned. The sunlight comes through millions of miles of vacuum, as we understand it, before it reaches the earth. If light is an emanation of luminous material, we ought to see it anywhere in space. A well-known experiment proves that this is not true. Take a straight tube of sufficient length and let another cross it so that you can look through the first tube at right angles with its length. Coat the inside of these tubes with lampback, so the inner surfaces will not reflect light. Place this in a dark room, letting one end run through into the light of another room, or out of doors. Direct a strong ray of light through the tube, and a bright spot will appear on a screen in front of the inner end.

Now, if light was simply an emission of luminous particles, we should be able to see the beam as it passed through the cross tube. Upon looking through the cross tube, which passes directly through the beam, no light is seen; showing that it is only luminous when it strikes some material substance capable of reflecting it to the eye. If we could be shot up into space a million or two miles from the earth, or from any planet, the earth would look to us like the moon or one of the stars; and while we could *see* the sun, moon, and stars, we would be in comparative darkness. The space between the planets and stars would be black as night. There would be such a small material reflecting surface that the sensation of light about us would be very small as compared with that at the surface of the earth. The reason why it is so light to us down here is, that there is such a vast reflecting surface which diffuses the light in all directions. The atmosphere plays an important part in the reflection and diffusion of light. Who has not observed that the light is brighter on days when there is a little haze in the atmosphere and when the sky is partly covered with clouds which act as reflectors of light? Who has not observed that a *very* clear, cool day, such as we have sometimes in early summer or in the fall, when no trace of cloud or haze is to be seen, that notwithstanding the air is exceptionally clear, it does not seem so light as when *not* so clear. As a matter of fact, it is not so light, on account of the absence of the before mentioned reflection.

Having given some idea of the physical character of light and heat, let us now pass for a moment to the consideration of that expression of force called electricity. Force is transmitted electrically with far greater speed than by any other known process where a ponderable material is the medium of such transmission. Its speed, however, does not compare with that of light or radiant heat through an ordinary conductor, but it is incomparably greater than heat when transmitted by the molecular process, that is, by the impact of one atom against another consecutively.

There is no standard rate of transmission for electricity, as it varies greatly according to the quality of the conductor. Under some circumstances its speed may be as great as that of light or even greater.

Perhaps there is no branch of science that so baffles the student as electricity and its nearest of kin—magnetism. Owing to the numerous theories that have been held regarding electricity, the nomenclature has

been very confusing and very misleading. Growing out of the old idea that electricity was a fluid, the term "current" has fastened itself upon the science, as an expression of the electro-dynamite condition of a conductor.

Notwithstanding we know so little about electricity, there are but few men in these times who do not believe that it is only a condition that matter assumes under certain circumstances, and not matter itself. Just what this condition is we find it hard to explain. There is strong evidence, however, that electricity, like heat, is molecular motion. Heat motion, as expressed by the movement of the molecules of matter, is sluggish when compared with electric molecular motion. The difference between the two motions may simply be in rate, or it may be in form, or in both; most likely the latter. With heat it would seem that the molecule has an orbital or circular motion, and that their planes of motion do not coincide as, for instance, in polarized light, but are like the unpolarized rays where the planes of vibration radiate in all directions. This would seem to be the case from the fact that a heated body expands in all directions. An electrified conductor does not perceptibly expand unless there is a conversion into heat. The molecular movement is probably in the same plane, and the energy is propagated by the impact of one atom or molecule against another successively.

Such a motion would be more rapidly transmitted through a conductor than the one described as heat motion. Electricity would seem to represent the working energy expended in changing from a high to a low potential. I do not mean that every such change would be so represented, for if we should elevate a weight of a given size and density from the ground, the measure of its ability to do work in falling, other things being equal, would be determined by its height. The energy expended in falling might be converted into mechanical motion and do work, such as the turning of wheels, or it might be converted into electricity or heat. If left free to fall through the air, after the weight had reached the earth, the energy expended in falling would exist in the form of heat; some caused by friction against the air, but mostly by the impact of the weight against the earth, which would cause a molecular motion in the weight and the earth, the mechanical equivalent of which, would be a force sufficient to elevate the weight to the same height from which it fell.

One important condition for the production of dynamic electricity is a circuit composed of some known conductor of this energy. If we place a piece of zinc and a piece of copper in a room of the same temperature, the zinc will absorb more heat than the copper. As a consequence the molecular motion of the zinc is greater than that of the copper. The amount of molecular motion in a metal is a measure of its potential; so that the potential of the zinc is greater than that of the copper. Now, energy in action is always from a higher to a lower plane; if the energy is potential, or at rest, the tendency is from a higher to a lower. If we arrange these two metals in a circuit in the form of a galvanic battery, the higher potential will descend to the lower in the form of electricity, and its passage will do work. The higher potential is not released until the acid dissolves the zinc. As the dissolution progresses, the potential energy becomes kinetic and falls to the lower plane, and in its descent the energy takes the form of electricity. It is a well-known fact that if we heat one part of a metal ring, a current of electricity is set up; but as soon as the ring becomes equally heated throughout, the current ceases. At first the potentials of the different parts of the ring were unequal, and a flow of energy is set up as a consequence of the process of equalization. According to the above, there would seem to be a close relation between heat and electricity, and that under certain circumstances it acts as an equalizer of heat.

We have already shown the close relation between heat and light. Now let us see what relation electricity bears to both, and what relation they all bear to each other. I have shown that the unequal distribution of heat produces electricity. Every schoolboy knows that electricity produces heat and light. As an instance, we cite you to the electric light that may be seen any evening.

The convertibility of these expressions of force, the one into the other, is perhaps the strongest proof of their identity of origin.

As we said at the outset, the particular expression depends upon the quality and relations of the material upon which force acts. Here is one of Crooks's tubes. It consists of a series of three glass bulbs exhausted to the millionth of an atmosphere. They are made of three different kinds of glass. In ordinary light these look alike, but there is a difference of texture. One is uranium, one English, and one German glass. There are only a few air molecules left in the bulbs. So few, that only one may be projected the whole length of the tube without striking its neighbor. When I turn on a current of electricity, the atoms are violently thrown against the sides of the tube. The result of this violent impact is heat and light. The tube becomes hot and luminous, showing a very high degree of molecular excitement. You all see that the light in the different bulbs is differently colored. Now the same force is acting on all. The different expression is not because the force is different, but because it acts on material having a structural difference. Here is also an instance of the conversion of electricity into heat and light. [*Iceland spar.*] I will now show you an instance of the conversion of heat into electricity. I have here what is called a thermo-electric pile. It consists of alternate layers of antimony and bismuth bars joined at their extremities, so as to make a continuous circuit terminating in these binding screws.

If these binding screws are connected by a conductor of electricity, and the temperature of the face of the pile is raised or lowered in the least, a current of electricity will flow through the circuit. If raised in temperature, it will be in one direction; if lowered, in the opposite. Now, if I include in this circuit a galvanometer, the deflection of its index needle will show the presence of a current, and also its correlative heat or cold. I have arranged it so that an image of the needle will be thrown on the screen. Now, I want to prove what I told you about the falling weight—that a stoppage of its mechanical motion resulted in heat or molecular energy.

I have here a strip of metal, and as it has been lying some time, it is probably of the same temperature as the thermal pile, and will produce little or no effect upon the needle. I will give it a few blows with a hammer, and again apply it to the face of the pile, and you at once see a decided deflection of the needle,

Let us now trace the transmutations of energy so far as we have gone, starting with the blow of the hammer. Here mechanical energy has been changed into molecular in the form of heat. A part of this heat is found in the strip of metal. I applied it to the pile, and converted a portion of it into electrical energy, which expends itself partly in producing visible mechanical energy by moving the needle, which in turn is transformed into heat. Here are four transmutations—from mechanical to heat energy, from heat to electrical energy, from electrical to mechanical again, and finally from mechanical into heat. I have here a piece of copper wire, and, as in the case of the strip of metal, it is of the same temperature as the room, and produces no effect on the pile. I now bend it a few times vigorously, thus causing a friction between the particles, which produces a molecular excitement. This is shown, as before, by the deflection of the needle. All the transmutations are the same as before. I have only employed a different form of mechanical energy.

We have seen that electricity has produced heat and light, and that heat will produce light and electricity. It now remains to see what light will do in the way of producing electricity and heat.

It is more difficult to show the effect of light, from its very close relation to heat. It is clearly shown that light has powerful chemical properties independent of heat. Photography is an instance of its chemical power. It is also shown that light, when absorbed, becomes heat. And whatever becomes heat will become electricity.

If I should direct the sun's rays upon one end of this thermo-electric pile, while the other was covered, electricity would be generated. This result could be accounted for by the heat that accompanies the luminous rays. On the other hand, it is difficult to prove that every luminous ray is not in some degree a heat ray. Also, if all the luminous rays were shut off, and only the dark rays were absorbed by the pile, the deflection of the needle would show a less amount of heat absorbed. If we spread a black and a white cloth upon the snow, it will melt under the black cloth much faster than under the white, because all the sun's rays are absorbed by the former and converted into heat, while from the latter they are reflected.

It seems to me that the question before us to-night is fully answered in the operation of the electric light. It might be put in another way, and read, Have these phenomena—heat, light and electricity—a common origin? To illustrate, let us take the case of a waterfall. A waterfall is the result of what is called the force of gravity. The water, by the power of the sun's rays, has been placed in a position where the force of gravity can act upon it. The result is motion, or moving energy.

If we place a water-wheel in the proper relation to the fall, the wheel will turn and do work. Now we can, by the movement of this wheel, put in operation a dynamo electric machine which will generate a powerful electric current, which in turn may be carried to an electric lamp, where what was electricity takes on the form of heat and light. If we stop the wheel, the current ceases and the heat and light cease. All three exhibitions of energy came from the same source, namely, the waterfall. But this is not all the wheel will do. We could cause it to drive machinery that would produce every conceivable mechanical motion—circular, irregular, intermittent, reciprocal, pendulous, etc.

If the waterfall and wheel were large enough, we could at the same time light a city, drive a train of cars, and send ten thousand messages to all parts of the land, and have all these operations dependent upon the continuous turning of a single wheel. More than this, while all these operations were going on, we could strike the hours of the day in every clock tower in the land—not only could we strike the hours, but we could regulate the pendulums of the clocks. At the same time we could fire cannon, either simultaneously or successively, in every city of the land. We could warn every household of the approach of a burglar, and not only give warning, but on the instant of his entrance turn up the lights and illuminate the house. I might go on for hours reciting operations that could be carried on all at the same time and in different parts of the country, and all of them made dependent upon the continuous turning of one and the same wheel. This, however, is only the faintest conception of what is actually going on. The sun is the great source of all the operations of our solar system. It is the great master wheel that gives activity to all the machinery of our planet and many others like it.

All motion of material things, animate or inanimate, whether in the earth, on the earth, or above the earth, is the offspring of the sun's silent energy. He is alike father to the soft zephyr that fans gratefully the cheek, and the cold blast of winter which carries suffering, death and destruction in its course. The same genial sunbeam that makes all nature smile on a summer's morning, that gives life and joy to all animated things, that causes the leaf to grow and the flower to bud and bloom, that clothes all nature with beauty and loveliness—the same merry sunbeam, later in the day, brings the angry cloud, the pouring rain, the blinding flash of lightning, the terrific peal of thunder, and the still more dreadful tornado. By the magic of his spots the sun casts an undefinable shadow across our globe, thus causing a sudden change of potential in this great thermal battery, the earth, and an electric storm follows which paralyzes the telegraph service, and, for one day at least, he is king of Wall street. And at night, as if to show his contempt for man's puny inventions, he hangs an electric lamp in the northern sky, and another in the southern, and the two light the whole world. Such is an outline history of the frolics of the sunbeam for one day. The intermediary work done in connection with one day's events, growing out of the sun's radiant energy, could not be recited in a lifetime.

Finally, it is impossible to study closely the properties of matter and the various phenomena exhibited in its relation to energy, without coming to the conslusions that all energy, in whatever form it may appear to our senses, is the offspring of one common parent.

Use of Electric Light in Deep Sea Fishing.

The Albatross, the new steamer just completed for the deep-sea investigations of the United States Fish Commission, is equipped with a novel search-light which may result in a revolution in sea fisheries. It consists of three electric lights, each of 16-candle power, inclosed in a hermetically sealed glass case It is expected that when this lantern is sunk in the waters its glare will attract the fish, which can then be taken by a net drawn from beneath it. The contrivance is designed solely for use in securing rare fish from the bottom of the ocean for scientific purposes; but why might it not be employed in taking fish for food? The charm of a brilliant light for a fish is well known, and fishing at night with torches has been practised from the earliest times. If the large fish of the ocean are affected by a brilliant light as the fish of rivers and small streams are, the electric light may play an important part in the great industry of procuring fish from the sea for food.

At the meeting of the New York Electrical Society, Friday evening, April 6, it was decided to make its library a circulating one.

Mr. F. W. Cushing described the latest developments in harmonic telegraphy, and Mr. C. O. Mailloux read a paper by Geo. A. Hamilton, entitled "On a Simple Formula for Determining the Insulation of a Section of Wire, Measured Through an Intermediate Lead."

The next meeting of the society will be held at Stevens Institute, Hoboken, N. J. Prof. Henry Morton will deliver a lecture on "The Storage of Electricity."

Complimentary tickets of admission to this lecture can be obtained by applying to J. McKenzie, jr., Financial Secretary, No. 195 Broadway.

The certificate of incorporation of the Railway Telephone Company was filed to-day in the office of the County Clerk. The incorporators of this company are Chas. A. Randall, Andrew E. Smythe, Edmund K. Hyndman, and Philip P. Quackenboss.

The objects of the company are to buy, construct, use, and maintain lines of electric telegraph within the State of New York, and beyond the limits of the State, and also through the United States and adjacent countries.

The capital stock is fixed at $2,500,000, divided into 25,000 shares of $100 each. The capital stock may be increased to $5,000,000, by the consent in writing of a majority of the stockholders.

The works of the Cleveland Brush Electric Company, including their new addition, which is now almost completed, cover six acres of ground. A draft stack which the company have recently put up is capable of making a draft for engines and boilers aggregating 1,500 horse-power. Some time during the present month the company will begin to place the new Brush storage or secondary battery on the market.

Telephonic.

We hear a great deal at the present time from the opponents of the Bell telephone concerning the neglected schoolmaster of Friedrichsdorf, Philip Reis, and his claims, or rather the claims made for him by his advocates, to the inventorship of the speaking telephone.

It may be well enough for once to let him speak for himself.

The following is taken from the last number of the journal of the Society of Telegraph Engineers and Electricians, and is a copy of an autograph letter, written by Reis to Mr. Ladd, of London, who had become the purchaser of a Reis telephone. Mr. Ladd now presents the original letter to the above society:

(Copy.)

INSTITUT GARNIER,)
Friedrichsdorf.)

DEAR SIR: I am sorry not to have been in Francfort when you were there at Mr. Albert's by whom I have been informed that you have purchased one of my newly-invented instruments (telephones), though I will do all in my power to give you the most ample explanations on the subject.

I am sure that personal communication would have been preferable, specially as I was told that you will show the apparatus at your next scientifical meeting, and thus introduce the apparatus in your country.

Tunes and sounds of any kind are only brought to our conception by the condensations and rarefactions of air or any other medium in which we may find ourselves. By every condensation the tympanum of our ear is pressed inwards, by every rarefaction it is pressed outward, and thus the tympanum performs oscillations like a pendulum. The smaller or greater number of the oscillations made in a second gives us, by help of the small bones in our ear and the auditory nerve the idea of a higher or lower tune. It was no hard labor either to imagine that any other membrane besides that of our ear could be brought to make similar oscillations, if spanned in a proper manner and if taken in good proportions, or to make use of these oscillations for the interruption of a galvanic current.

However, these were the principles which guided me in my invention; they were sufficient to induce me to try the reproduction of tunes at a distance. It would be long to relate all the fruitless attempts I made until I found out the proportions of the instrument and the necessary tension of the membrane.

The apparatus you have bought is now what may be found most simple, and works without failing when arranged carefully in the following manner:

The apparatus consists of two separated parts, one for the singing station A, and the other for the hearing station B. The apparatus A is a square box of wood, the cover of which shows the membrane *b*, on the outside, under glass. In the middle of the latter is fixed a small platina plate to which a flattened copper wire is soldered, on purpose to conduct the galvanic current. Within the circle you will further remark two screws, one of them is terminated by a little pit in which you put a little drop of quicksilver, the other is pointed. The angle which you will find lying on the membrane, is to be placed according to the letters, with the little hole *a* on the point *a*, the little platina foot *b* into the quicksilver screw, the other platina foot will then come on the platina plate in the middle of the membrane.

The galvanic current coming from the battery (which I compose generally of three or four good elements) is introduced at the conducting screw near *b*, wherefrom it proceeds to the quicksilver, the movable angle, the platina plate, and the complementary telegraph to the conducting screw *s*. From here it goes through the conductor to the other station B, and from there returns to the battery.

The apparatus B, a sonorous box, on the cover of which is fixed the wire spiral with the steel axis, which will be magnetic when the current goes through the spiral. A second little box is fixed on the first one, and laid down on the steel axis to increase the intensity of the reproduced sounds. On the small side of the lower box you will find the corresponding part of the complementary telegraph.

If a person sing at the station A in the tube *x*, the vibrations of air will pass into the box and move the membrane above; thereby the platina foot *c*, of the movable angle will be lifted up, and thus will open the stream at every condensation of air in the box. The stream will be reëstablished at every rarefaction. In this manner the steel axis at station B will be magnetic once for every full vibration, and, as magnetism never enters nor leaves a metal without disturbing the equilibrium of the atoms, the steel axis at station B must repeat the vibrations at station A, and then reproduce the sounds which caused them. Any sound will be reproduced if strong enough to set the membrane in motion.

The little telegraph which you find on the side of the apparatus is very useful and agreeable for to give signals between both of the correspondents. At every opening of the stream, and next following shutting, the station A will hear a little clap, produced by the attraction of the steel spring. Another little clap will be heard at station B in the wire spiral. By multiplying the claps and producing them in different measures, you will be able as well as I am to get understood by your correspondent.

I am to end, sir, and I hope that what I said will be sufficient to have a first try; afterwards you will get on quite alone. I am, sir,

Your most obedient servant,

PH. REIS.

Friedrichsdorf, 13–7–63.

To Mr. William Ladd.

The Government is engaged in a controversy with the Bell Telephone Company. Many telephones are used in the public service, especially by the Signal Corps. Since the war much attention has been paid to the improvement of means of communication between different parts of an army in the field and on the march, and a field telephone has been invented by Sergeant Eccard of the Signal Corps. The same man has improved the instruments employed at the sea coast stations, by which communication is maintained between the men of the life-saving and signal services. The former are thus enabled to send word for aid to distant ports in cases of serious disasters on the coast. Eccard's combination of his own receiver with the Gray, Phelps and Edison transmitter is asserted by Government officers to be so much better than the Bell telephone that it is necessary for the proper conduct of the public business. The Eccard instruments are made with a view to heavier work than the Bell telephones are usually put to. Moreover, the officers of the Signal Corps think that the Government ought to be in position to avail itself of the inventions of the French and Germans, some of which are very valuable for military purposes. The question involves the right of the Government to use any invention that may be deemed for the best interests of the public service, for the Bell Company insists not only on charging a rental for each telephone used by the Government, but that all telephones other than those covered by Prof. Bell's patent shall be destroyed or surrendered. The Bell people say that the Government shall not use or manufacture any telephones that are not made under their patents. As soon as possible the question will be submitted for the opinion of the Attorney-General.

New Orleans will soon Talk With Outside Towns.

It is just three years since the telephone was introduced in this city. Since the introduction the business has grown enormously. In order to give the public an idea of its growth and the improvements which are going on, a *States* reporter, paid a visit to the executive office of the company. Mr. W. W. Huck was in charge, from whom the following facts were obtained:

THE LOUISIANA TELEPHONE COMPANY

has 876 subscribers connected with the New Orleans Exchange, and the number is increasing regularly. There are nineteen exchanges in operation in the territory, which comprises the States of Louisiana and Mississippi, and the number of subscribers for all the exchanges are 1600. There are also

MANY PRIVATE LINES,

some of them quite lengthy, notably, that of the New Orleans and Northeastern Railroad, which is 180 miles long, and operates 14 stations. Connections are constantly carried on over the entire line, which extends from Meridian to the station opposite Point aux Herbes.

The Georgia Pacific Railroad also operates a telephone line between Greenville and Johnsonville, 48 miles.

The instruments employed are similar to those used in this city and elsewhere.

The company has now under contract the building of a line connecting this city with Donaldsonville, Plaquemines and Baton Rouge. It is expected that this line will be ready for business by the fifteenth of June, when conversations between these places will be as readily had as is now so common an occurrence between persons in this city. This line will be operated upon an admirable system. Subscribers in New Orleans, desiring communication with another subscriber in, say, Baton Rouge, has only to call the exchange, as is now done for local communications, and tell the operator to connect line with the desired subscriber in Baton Rouge, the connection is at once made and the two converse in the usual manner. For these communications a regular toll will be charged to the subscriber who requests the connection.

THE TOLL FOR COMMUNICATIONS

between New Orleans and Baton Rouge will be 60 cents for a conversation of five minutes or less, and at that rate up to ten minutes, which is the limit of communication. The average telephonic conversation is about two minutes. It will thus be seen that five minutes is very ample time for a communication.

In connection with this line will be a branch extending down the Bayou Lafourche from Donaldsonville so that conversation can also be had with Napoleonville and the surrounding country.

A line is being constructed to connect Bayou Sara, Jackson and Clinton. This line is nearly completed.

It is contemplated to extend the line from Baton Rouge to Port Hudson and Bayou Sara and Woodville, thus permitting of telephonic communication between this city and those towns.

The company is also

BUILDING A LINE

between Grenada and Memphis, also another between Holly Springs and Memphis.

Next season it will connect Vicksburg with Yazoo City and with Greenville and Arkansas City.

In addition to these the company are connecting by telephone Monroe and Bastrop. And to still further utilize this convenience it is now negotiating with the Southwestern Telephone Company to construct a telephone line between New Orleans and Houston and Galveston.

It will thus be seen that our telephone interests are quietly but rapidly expanding and assuming immense proportions, and it is a matter of but one or two years when we will hold regular converse with our friends in Natchez, Vicksburg, Greenville, Arkansas City, and even with Memphis.

Imagine ourselves seated in our offices or homes conversing with parties in Vicksburg and exchanging orders, etc., as is now so common an occurrence between our local business men.

LUXURIES OF THE TELEPHONE.

Imagine a party about to embark on the Mississippi Valley train, at Baton Rouge this evening, calling up West End, or Spanish Fort, or Shell Beach or Milneburg, and ordering a fish breakfast for to-morrow morning—great Jupiter! and yet such things will soon be an every-day occurrence.

Long Distance Telephoning.

Considerable interest has recently been manifested in telephonic and business circles relative to the practical extension of the long-circuit telephone system of communication between the chief commercial centers of the nation, based upon the same principle as that provided by the electric telegraph.

With a view of posting the readers upon this subject, a reporter visited Mr. Henry Bentley, of Philadelphia, a gentleman largely identified with telegraphic, telephonic and similar enterprises and thoroughly conversant with their details and operations.

Mr. Bentley's attention was directed to a report of certain experiments alleged to have been made in New York under the auspices of the Postal Telephone Company for the purpose of testing the efficiency of this telephonic system between that city and Chicago.

Mr. Bentley replied:

"These experiments are all old; there is nothing new about them. Of course they are interesting, but possess no novelty whatever. Experiments perhaps surpassing these in importance were made years ago by the old-fashioned Edison carbon transmitters. In fact the experiments to which you refer are simply for effect. They afford the postal telephone companies a means of free advertising, thus drawing public attention to their schemes and enabling them the more readily to dispose of stock."

NO CONNECTION WITH NEW YORK.

"Granted that such is the case, do you consider it practicable to establish direct telephonic communication between Philadelphia and New York?"

"So far as the mere mechanical stretching of wires and transmission of sound are concerned, yes; but if I may anticipate your next question as to the speedy development of such system, then I answer distinctly no, and for obvious reasons. In the first place it has never yet been demonstrated that a continuous wire of 100 miles is necessary. Such a wire has never been called for or demanded for any purpose, financial or otherwise. Then, again, it would be a very unsatisfactory venture. Telephone wires can never run in close proximity to telegraphic wires with any satisfaction, as the introduction of the latter would be very apt to interfere with them and cause an unavoidable confusion in the sound transmitted. This might be temporarily avoided by making a detour of the telephone wires at some distance from the telegraph wires; but allowing for this, the two sets of wires, on entering or leaving a town, would probably come into contact by crossing or otherwise, which would interfere with the working of both, more especially with the wires transmitting sound."

"In the event of all these difficulties being overcome would such a line pay?"

IT WOULDN'T PAY.

"Decidedly not. How could it? You may accept it as a fact that no system of telephony which extends beyond a radius of 20 or 30 miles from any city, however large, will prove a paying investment. As an illustration, we have a wire stretched as far as Trenton, but no further. Why? Because people living on the other side of Trenton have no use for Philadelphia, and don't care to telephone us. The next important point beyond Trenton is New Brunswick, and all its telephone business is transacted with New York. So with Wilmington, up to that point our wires extend and pays, but beyond that Baltimore steps in and secures what little business there may be. Another reason, and a valid one, why this lengthened system of telephonic communication would not be feasible is, its utter inadaptability to commercial purposes. All transactions in the world of commerce or finance have to be recorded. There must be a record of everything. The telegraph provides for this, the telephone does not. Mr. A. will not sell 10 car loads of corn on the strength of mere sound, or Mr. B. 10,000 bushels of wheat on a simple telephonic order. They would be foolish to do so, because there would be no record of such sale, and consequently no responsibility. The telephone represents honor, but that is all; it is not a commercial

record. The telegraph, on the other hand, is essential to commerce and depends for its success—pecuniary of course—upon the three great mainstays—finance, commerce, and manufactures. Outside of these it would not pay. The use of the telegraph for mere social or domestic purposes would not defray wire maintenance and service, to say nothing of profits or dividends. And so with the telephone, it, like the telegraph, is sustained by these three props, and even they are of no paying value whatever when extended beyond a radius of 20 or 30 miles from any one city. There are other items also to be taken into account in discussing this matter of continuous or lengthened telephony which involve considerable outlay, such as the shifting and connection of wires, the substitute of stout for thin wires, so as to withstand the violence of wind, storms, distance, etc."

ITS USE LIMITED.

"Then, Mr. Bentley, you do not think it probable that direct telephonic communication is likely to be established for the near future between Philadelphia and New York?"

"I do not, and for the reasons already given. As I told you, it is comparatively easy to hold telephonic intercourse between Philadelphia and New York or Chicago, but it can only be satisfactorily accomplished when ordinary telegraphic operation is suspended, say on Sundays or during the night when there is little or no induction of the telegraphic wires. But for purely commercial or financial interests the telephone will not come into favor as a medium of direct transmission between large cities. The telephone, like any other enterprise, is valuable so long as it pays, and when it ceases to prove profitable in a pecuniary point of view, its scientific uses will not avail much. To sum up the whole matter, the value of the telephone is confined, as I have mentioned, within a certain radius—that's where its money lies, and beyond that it has no money-earning capacity." —*The News.*

THE DISCOVERY OF THE "CLOSED CIRCUIT" PRINCIPLE OF TRANSMITTING SPOKEN WORDS OVER TELEGRAPH LINES.

By H. C. Strong.

In regard to what I consider as my claim to priority of invention or discovery of the principle of transmitting spoken words by electricity, or "polarity," as I choose to term it, as also my knowledge of "platinum," I herewith submit the following:

I came to Chicago from Ohio in the spring of 1856, and worked at my trade in a printing office for a short time, and then went to Galesburg, Ill., and then to Knoxville, and printed the first number of the *Knox Republican* on the hand-press on which that paper is now printed. While at Knoxville I planned the newspaper Union publishing business as now conducted, and urged several printers to join me and go to Chicago and start the enterprise, but I found I was too far ahead of the age, and gave it up.

At that time I became acquainted with Henry Nelson, a young man living near Galesburg, who had invented and constructed an electro-motor propelled by electricity on the polarity principle. Mr. Nelson had exhibited the engine in Knox and adjoining counties with indifferent success. The machine weighed about three hundred pounds, *and carried one or two persons.* The power was derived from *two metal cups*, or *cells*, composed of *platinum*, *mercury* and *acids*, and the *polarity of the magnets* created the action, the speed being regulated with a "brake."

I purchased the motor and employed Mr. Nelson to charge the cups, as they had become exhausted. In conversation with Mr. Nelson, he warned me against undertaking the task of explaining to the public the polarity action of the motor, telling me that my statements would not be received at that early day, but that I would be condemned by would-be-scientists, as he had been slandered by contending for the principle of polarity as applied in the motor.

I was at that time very sure that I could converse over the telegraph wires by the law of polarity as now done by telephone, and I so told Mr. Nelson, and he replied: "We are twenty years ahead of the time in this particular science, but if we could get *platinum* in large quantities, and cheaply, we could run motors practically."

I heeded Nelson's advice and sold the motor to a Mr. Lewis, who took a partner and started for Peoria in a wagon with the motor, and I returned to the *Republican* office and printed the first hand-bills for the showmen, and wrote the heading as follows:

"TRIUMPH OF AMERICAN GENIUS!"

"Come and See the Great Electrical Wonder!"

"*No more Steam Power. All Kinds of Machinery to be run by Electrical Power!*"

The result of the announcement "in the bill" was to get Lewis into arguments and accusations of being an imposter—"that the engine was *not run by electricity at all*, but was wound up like a clock and made to run only one way, and not backward." Mr. L. informed me, when I met him, that he had to suppress "the bills" I printed for him, and get others printed, stating that the "Great Motor" could be seen for twenty-five cents, and the people could judge for themselves, and continued to exhibit the motor in small towns along the Illinois River, shipping the engine on the deck of steamers stopping at the towns. I met Mr. Lewis at Peoria, waiting the arrival of the boat from Pekin with the motor, but when the boat came the motor could not be found, and Lewis supposed some enemy of his had run it into the river from the boat, and he was feeling very sad, as he had made considerable money with it.

Time passed on. I never forgot the polarity motor and its singular disappearance, but I knew then, and know now, that the same undeviating law of polarity that ran that motor, and now shown in the telephone, would enable me, some day, to talk over the ordinary telegraph lines, and I at that time contended for the principle.

During the year 1866, when the Atlantic cable was successfully laid, and ten years after I had introduced the polarity motor to the world through Lewis & Co., I was conversing with a telegraph operator about my experience, when the *Chicago Daily Times* came to hand, containing the account of an operator on the cable going down to the sea shore and placing in the water the ends of the wires, connected to an "electrometer" at a point where the cable came out of the ocean, in order to see if the "cable leaked electricity," when, lo! he got dispatches passing over the cable, and read them in the office of the company. The surprise at this feat was great among the cable officials, and they could not comprehend how it could be possible that the messages were thus received.

After I had read the *Times* article to the operator, I declared to him then that I fully understood the law of elecricity by which the signals from the Great Eastern were received—that it was by the earth circuit—and that vocal sounds could be transmitted on the same principle, and that I could talk over the telegraph wires on that principle, just as I was then talking to him, and that I would do so when the time arrived, as it was only a question of time.

In 1875-6 I obtained a pair of Morse telegraph "sounders," and removed the armatures and placed tin-cans on the ends of the electro-magnets, with a battery and *closed circuit*, and told my wife to talk aloud in one of the cans while I listened in the other at the remote end of the line. After several trials, I became satisfied, from what I then heard, that conversation could be carried on over the ordinary telegraph wires, with a "closed circuit" arranged just as I had it then, with battery and instruments, and the line "grounded" at each end and circuit *closed!*

A Pennsylvania court has decided that the transfer of credits and debits by telephone is as valid as that by word of mouth, in which there is no actual evidence in writing of the transaction.

The New Gilliland Magneto Bell.

We have just examined carefully the new Gilliland bell, the first of which are just about being sent out to telephone exchanges.

This bell, illustrated herewith, embodies several new and important features, and from the favor with which it is being received by practical men, we are warranted in believing that it will supplant to a large extent the bells now being used.

The principal feature of the new bell is that it is in an iron case, instead of a wooden one. The front of the box is mahogany, and by unscrewing three large screws on the face, the entire works of the box are taken off with the front, thus admitting repairs with the least amount of difficulty.

There are no wire connections inside of the box, all connections being copper strips.

The most noticeable thing of the works is the size of the magnets, which are large and include all of the gearing inside of the horse-shoe shape.

The bell is exceedingly strong, being able to work over 18,000 to 20,000 ohms resistance.

There are many improvements on the old bell, in detail, such as adjusting the ringers, and other small matters, which, we have no doubt, will greatly delight the practical exchange men.

On the whole, we think the bell will justify the anticipations of the manufacturers. It was for a long while promised, but the result was worth waiting for.

The Western Union Dividend.

The Mercantile Trust Company began to pay the stockholders of the Western Union Telegraph Company their dividends on the 12th inst. The whole amount to be paid is $240,000, which will include that part of the January dividend which was not paid. The dividend is 1¼ per cent. on $80,000,000. The stockholders execute an assignment of their right to the dividend to Mr. Gould, and receive a check for the amount from the Trust Company.

Col. R. C. Clowry, General Superintendent of the Central Division of the Western Union Telegraph Company, is attempting to solve the question of the location of telegraph wires in Chicago. There has been a raid on wires strung on poles in Chicago, and a demand that they be placed under ground. They cannot be operated under the ground in such streets as those of Chicago. Indeed, the cry about burying wires is ridiculous. The conditions to make it a success do not exist. Col. Clowry's solution is to use cables on poles, and this is the account given by the Superintendent to a reporter:

"We intend putting up the cables as fast as possible, and clean out at least all the trunk lines down town. There are, however, a great many wires running into buildings for tickers and private lines that cannot be removed. But we propose to cable all the wires we can, have boxes on the poles wherever practicable, and run wires for the cables on the roofs into buildings. Each cable contains eighteen wires, and as they will be fastened to short arms, four of the cables will do away with seventy-two separate wires and twelve arms—quite a bunch to remove. The four cables will be little or no obstruction. The present poles will remain for a while, but, ultimately, none over thirty-five feet high will be used at the street corners (shorter ones will be put in the middle af the blocks), and the cables will be so attached to the arms that they can be dropped into the street when it is necessary to raise a fire-ladder against a building."

The Action of the Microphone.

During the discussion which followed the reading of Mr. Munro's paper on the "Theory of the Microphone" at the last meeting of the Society of Telegraph Engineers and of Electricians, Mr. Augustus Stroh described a very interesting experiment which he has performed with a view of elucidating this obscure and puzzling problem. He arranged a delicate "hammer and anvil" microphone of carbon, and attached a small reflecting mirror to the movable carbon in such a way that a beam of limelight reflected from the mirror on a screen would move down if the carbon points separated, and up if they came closer together. The microphone was connected in circuit with a battery, an interrupting key, and a telephone. On breaking the circuit with a key, Mr. Stroh found that the spot of light suddenly shifted upwards, thereby indicating a closer proximity of the points. On the other hand, when the circuit was closed by the key again the spot returned to its original position. The ticking of a watch placed on the wooden base of the microphone failed, however, to give any movement of the spot of light, perhaps because the conditions of this particular experiment were not quite delicate enough. The distance through which the light moved was very small (1 millimeter with three bichromate cells) but quite noticeable. Mr. Stroh also found that when a microphone failed to work the spot of light was seen to jump up at the instant of stoppage, and return when the instrument was re-adjusted by a tap on the table. It was, he says, only during the clear working of the telephone that the light remained steadily deflected downwards, a fact which seems to indicate that the carbon points are not in actual contact when the microphone is transmitting. We may add that M. Ochorowicz has, after some recent experiments, arrived at the conclusion that whatever be the elasticity of the springs keeping the points of a carbon microphone in contact, or the nature and extent of the contact surfaces, it is always possible to obtain good acoustic results from the telephone in circuit provided the contact between the points is slight, that is to say imperfect and under feeble pressure.—*Engineering.*

Calcutta, East India, March 16th, 1883.

In Bombay the telephone business has been established by a local company, which is an off-shoot of the Oriental Telephone Company, with a capital of 900,000 rupees (equal to about $480,000) in 38,400 shares of 25 each. This company (Bombay Telephone Company) has paid to the Oriental Telephone Company of London, 720,000 rupees for their business, patent rights, &c., half in shares and half in cash. They are at present in a most flourishing condition, under the superintendence of Mr. E. F. Moody, with 166 subscribers and some private lines.

Bombay has also as much electric light as is good for it, but does not seem to take kindly to it as other places, which I suppose is mainly due to the fact that the machines &c., do not give such satisfaction in this country as they do at home.

I am yours, very sincerely, "Bengali."

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NEW YORK, APRIL 19, 1883.

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A Good Use for a Bad Illuminant.

Those who are not yet convinced that gas will furnish more light when used as a fuel to drive a dynamo-electric machine than directly as an illuminant, may be likened unto the old man in the fable that went around with a cloth over his eyes declaring that he could see nothing.

The experiments recently made in the exhibition hall of the London Aquarium, to say nothing of the many tests that have from time to time been made during the past few years, have demonstrated this fact beyond peradventure. Hence it is but fair to assume that in the not distant future the electric light, when not generated by the power of running streams, will be generated through the agency of gas used as a fuel.

The following table is given by M. Niaudet as an exhibition of the results obtained by different experimentors in measuring the light that one horse-power (75 kilogrammeters) will yield. The results are given in Carcel units :

1. Voltaic arc, distance of carbons, 10 centimeters (4 inches); maximum numbers not to be reached in practice ; ordinary Gramme machine (Fontaine)..... 585
2. Voltaic arc, distance 3 c. (1⅛ in.) ordinary running ; Gramme machine (Fontaine)..... 230
3. Voltaic arc ; number given by the President of the Committee on Lighting by electricity, was 2,400 candles (9.6 candles=1 Carcel)... 250
4. Jablochkoff candle ; Gramme machine with alternate current ; one candle requires five-sixths of a horse-power (Honoré), and gives, according to Joubert, 41 Carcels ; so that each horse-power equals..49.2
5. Edison's incandescent lamp gives, according to Rowland and Barker.....11 to 21
   According to Bracket and Young. 19
6. Swan's incandescent lamp gives 150 candles (9 candles=1 Carcel)..... 16⅔

In a lecture recently delivered at Stuttgart before the Wurtemburg Society of Engineers, Prof. Von Marx said that a gas motor using illuminating gas, consumes on the average about one cubic meter (37 cubic feet) per horse-power of 75 kilogrammeters or 542 foot-pounds. An Argand burner, on the other hand, consuming 150 liters, 5 cubic feet of gas per hour, gives a light equal to 18 candles, and a cubic meter of gas will give a light equal to 120 candles ; and, reckoning a Carcel burner as being equivalent to nine candles, this corresponds to 13⅓ Carcels. The numbers which will be found in the table above, are, as will be seen, all higher than this, and more especially those with the electric arc ; but there is no doubt that even the incandescent lamps can economically compete with gas.

A comparatively large portion of the chemical energy of illuminating gas is converted into heat and only a very small portion into light; while, on the other hand, with the electric light, the converse is true ; by far the larger portion of the energy being turned into light, and but a comparatively small portion into heat.

Prof. Von Marx argues, therefore, that, if the electric light is, for equal intensity of light, already cheaper than gas light for illuminating large areas, it is not improbable that, owing to the profound attention now being given the subject, the same will at a no distant day be true of the small incandescent lights as well. When that time comes gas as an illuminant will be useless, but gas as a fuel will be invaluable.

From One Extreme to the Other.

We are glad to find our esteemed contemporary, the *Journal Télégraphique* of Berne, coming to look at the electric-accumulators from a more hopeful standpoint. M. Rothen, an adjunct-director of the Swiss telegraphic system, has, through several issues of the journal in question, contributed interesting articles on the accumulator, wherein his condemnation was more than inferential. Judging from the article from the same pen, now before us, we are led to hazard the opinion that heretofore M. Rothen has been familiar with the Planté and Faure types only, and that quite recently he has been shown the Sellon-Volkmar type.

If the article in the current number entitled *Nouvelles études sur les accumulateurs* may be taken as a candid expression of his opinion, he would seem to go as far beyond the limits of the real value of the new pattern, as he fell short in his estimate of the old. The Sellon-Volckmar accumulator is unquestionably of value if for no other reason, at least, because it furnishes a base from which a much more efficient apparatus may, not unreasonably, be expected ultimately to be evolved. That is all.

With all respect for M. Rothen, we think that he has done Planté a grave injustice in not remembering, while ridiculing the value of his device, that it was at least unique; that he planted the seed which others, to a certain extent have gathered, and that the originator of even a crude device confers often a greater boon to posterity than they who assist in perfecting it. His reason for discarding the claims of Planté are as two grains of wheat hid in two bushels of chaff; you shall seek all day ere you find them, and when you have them they are not worth the search.

Guarding Against Fire—Electricity the Faithful Sentinel.

The protection of life and property from the ravages of fire has been a chief object of human solicitude from the most remote age. Until recently, efforts were directed to produce appliances to put out fires that had gained the proportions of a conflagration. At present the idea gains ground that it is possible to wholly prevent conflagrations by controlling fires in their incipient stage by automatic devices, and we are led to notice what wonderful results have been reached.

For twenty centuries but little improvement was made in fire-extinguishing methods or appliances. The first hand-engines were simply a double-cylinder pump in a box. They had no air-chamber, no wheels, and the intestines of an ox served for hose.

This sort of apparatus may have been considered "a daisy" of an invention by Hero and his syndicate, but they would blush to own it now, could they see the modern steam fire engine, blazing in its splendor of burnished metal, and with the power of a giant, and the perfection of grace in its rapid movements, delivering vast volumes of water to any distance.

Side by side with the improvements in engines for putting out fires, improvements have been going on in the appliances for preventing fires.

In 1812 a system was devised which consisted of perforated pipes, extending along the ceiling of each room of a building, and from which the water was normally excluded.

The pipe leading to each room was provided with a cock outside the building, by means of which water could be turned on to any room in which a fire was known to exist.

This system caused water damage by the flooding of the entire room.

(It was probably first used in Lowell, Mass., although introduced in England cotemporaneously.)

Many factories in both Europe and this country were equipped with the perforated pipes, and many fires prevented by its use.

In the year 1852 a new thought came to the world through an accident. A building took fire, and the fire became extinguished by the melting off of a lead water pipe in which water was held under pressure.

This self-inaugurated improvement was so effectual that the fire was put out before the fact was known that the fire had occurred. As a result of this accident, a system of automatic fire extinguishers was soon after devised and put in a factory.

It consisted of pipes arranged to conduct water along the ceiling of each room, the pipes being in parallel lines about ten feet apart. At intervals of ten feet or so, a short branch or nozzle was joined to the pipes The pipes were kept filled with water under pressure.

The nozzles were a perforated rose-head sprinkler of hard metal, provided with a cap of easily fusible metal fitting tightly over the same, the design being to have the cap melt off when a fire occurred in the vicinity of a nozzle, and when the nozzle became uncapped by the melting of the cap, the water would be discharged through the perforations in jets so directed that each nozzle or sprinkler would, with a pressure of forty pounds, wet down ten feet in area of the floor beneath, and put out the fire without any damage from water to but so much of the building as was in danger.

The sprinkler so made was defective. The water being against the inside of the thin cap kept it chilled, and prevented it from melting readily, and when the fire became sufficiently hot to melt the cap, it would melt a hole in one side of the cap. The water escaping from the hole would at once end the process of melting, and a fizzling stream of water only would be had. To remedy these defects, a rose-head sprinkler of hard metal was uesd, with a cap, also of hard metal, fitted over the sprinkler and soldered around its edges with an easily fusible solder. The thin cap was, however, chilled by the water in contact with its interior, which retarded the melting of the solder, and if the cap became partly unsoldered, and was not at once torn off by the water pressure in the pipes, the water escaping from the unsoldered part prevented the further melting of the solder, and defeated the proper operation of the sprinkler.

Various modifications of this class of sprinklers were made—some that were designed to be closed with a seal inside the sprinkler, that would be released by the action of heat, and drop down and allow the water to discharge through perforations. All of this class of sprinklers, when subjected to the test of time, became clogged and stopped up by dust and lint from without or by rust and sediment from within, making them still more unsatisfactory and unreliable. Their use, however, led to a study of what is essential to make a perfect automatic sprinkler, and it resulted in the production of a sprinkler that will open under a temperature of 140° Fahr., and has none of the defects of the perforated sprinklers with water in chilling proximity to the fusible parts.

In the improved sensitive sprinkler the water does not chill the fusible alloy, and no water can escape until the retaining devices are fully released, when the sprinkler is allowed to become wholly open, delivering a half-inch stream, which is deflected into a spray by a plate placed a short distance in front of the discharge opening.

The benefits of a perfect system of automatic fire extinguishers cannot be over-estimated, and the mutual insurance companies realizing the protection they afford, will not insure a factory or warehouse that is not equipped by the best form of automatic sprinkler. Something like six hundred millions of dollars' worth of mill property is already protected by them, and although sixty factories have taken fire no instance of failure has occurred, but on the contrary they have put out the incipient fire before other appliances could be brought to act.

There are no more practical people than the insurance men of New England, and they can be safely followed by others, who should be convinced by the strong proof that such apparatus affords perfect security and fully insures the insurance companies. The value of property destroyed in the United States during 1882, was nearly $100,000,000. Hotels were consumed at the rate of nine a week, and other buildings in like proportion. The fire tax of the United States is fifteen per cent. of the yearly income of the people, and indirectly becomes a burden distributed among those not directly losers. Protection against the ravages of fire could well be made the subject of legislation, compelling property owners to avail themselves of every well-established safeguard to not only protect property, but the

lives of occupants of factories, hotels, and towering tenements.

Returning to the description of the fire extinguishers' system. It appears, however, that the fire extinguishing systems could not be perfect without the aid of that subtle agent, electricity.

It frequently occurs that a sprinkler becomes accidentally opened, and if water is kept constantly in the pipes a water damage is the result. Sprinklers that have become open by a small fire will continue to deliver water after the fire is out, and thousands of dollars of water damage has resulted from such indiscriminate use of water during a whole night.

To leave the water constantly in the pipes necessitates the expensive construction and maintainance of steam pipes through storehouses and mills to prevent the freezing of the water in the pipes. To overcome this difficulty a wire extends along the path of each pipe, and at intervals is held together by a drop of solder that will melt at a low temperature. This battery is charged by a gravity battery or from the earth, and a return circuit is made over the pipes. A normally open battery forms a circuit through a fine wire that rests against a combustible cord, which retains a valve against the water pressure from the street mains.

The pipes leading through the building being normally empty, and the street mains being properly connected to the pipes in the building, the action of heat makes operative the electric circuits, which in turn, through the action of heat generated by electricity by the normally open battery, instantly burns off the retaining cord and turns on a water supply, thus avoiding mechanism that will become inoperative by long disuse, and affording absolute certainty, as the pressure of the water itself does the work.

An alarm is included in the electric circuit, and notice given instantly when a fire occurs.

The circuits are so constructed and arranged as to make it impossible for them to become out of order by accident, neglect, or by design, without sounding the alarm. Consequently there is a certainty that the system will respond, or it will be known that it is deranged, and it can then be put in order.

It is surprising how far removed from complicated mechanism are the devices used to perfect the automatic system for extinguishing fires and giving alarms, the parts depending rather upon fixed laws which govern the action of currents and upon water pressure.

The perfected sprinkler and system is the invention of Mr. Charles E. Buell, of New Haven, Connecticut, who should feel proud of an invention that so effectually protects the property of communities.

Electrical Profanity.

A circuit judge in Ohio recently decided that swearing through a telephone could not be tolerated; that it constituted a violation of contract with the company furnishing the instrument and constituted a sufficient cause for its removal.

This decision will be read with surprise, and bring consternation from one end of the land to the other. The rule of the telephone companies, prohibiting swearing, has, up to the present time, been looked upon as only a refinement of sarcasm, as an indirect moral lesson, or, at the very worst, as but a fulcrum upon which, when hard pressed, they could place a lever of sufficient power to lift up the law against an objectionable patron.

It is the part of the moralist to metaphorically seek the highest hill, clap his wings, blow his horn, and call all hands to rejoice with him over this decision. Unfortunately, however, heterodoxy cannot be corrected by trepanning, nor profanity abolished by statute. We regret this sincerely, but, as practical men, are compelled to look things square in the face; to see them as they are—not as we would like them to be.

We have in our mind's eye an ideal world—a Utopia in which there is no wrangling, no brawling, no evil speaking, lying and slandering; where men approach the telephone with subdued voices, and, when interrupted in the middle of a message by a minion of the central office, politely ask his pardon, and patiently await his pleasure. But there would seem to be a something in the use of the telephone which is an incitive to wrath—a something that tries men's souls.

Those who have been in the habit of using this instrument, have doubtless, been surprised at the frequency with which unparliamentary language, not to use a harsher term, passes to and fro along the wires. Men who, in private life, are accustomed to select their adjectives with a scrupulous nicety, are audibly pictured by the telephone as engaged in heated controversies with the central office, made up in great measure of language not to be found in any current religious works.

Shakespeare portrays *Bassanio* as advising his friend *Gratiano* to "put on a sober habit, talk with respect, and swear but now and then." This is all very well, and had we been present we should have suggested that he swear not at all. But there was no telephone in those days. Had this been the case, and *Bassanio*, while talking over the wires with the fair *Portia*, been interrupted at a critical juncture, we should, doubtless, have been treated to a picture of *Bassanio* in the act of rejecting his own medicine to the following effect:

Bassanio [at the transmitter]—"Hello, central office, connect me with 125!" [Miss Portia's number.]

"Hello, hello, hello!"

Bassanio—"Have you connected me with 125?"

"Yes, yes, yes—go on!"

Now, Bassanio hails his Portia, gets her response, and begins to explain the loss of the ring:

"Portio, forgive me this enforced wrong; and, in the hearing of these many friends [the telephone subscribers, who are listening all along the line], I swear to thee, even by thine own fair eyes, wherein I see myself——"

[Central Office]—"Hello, hello! Ain't you through yet?"

[Bassanio, enraged at this interruption, which has caused him to lose the thread of his little protestation.]

"'Through yet?' No, I am not through yet not half through, and don't you forget it, you long-legged, impertinent son of a sea-cook! You interrupt me again like that, and I'll go down there with a club and clean out the whole place!"

We regret very much to be compelled to repeat such language, but honesty necessitates the reproduction of a supposititious case in similar terms to the real, and by candor only can we hope to make out our case, which is that a certain amount of invective is excusable in the use of the Bell telephone.

"When a gentleman is disposed to swear, it is not for any standers-by to curtail his oaths," says *Cloten* in "Cymbeline." The learned Ohio judge, is, however, inclined to the contrary opinion. He says: "The telephone reaches into many family circles; and it must be remembered that it is possible, from the peculiar arrangement of the instrument, that a communication intended for one individual will reach many others."

Doubtless many judicious persons would suggest that, as impurities in a stream may be rectified at its source, swearing along the line of the telephone might be curtailed by disciplining the central office clerks who incite it. This is, however, a mistake. So many persons are so inconsiderate as to take up more time in sending a message than is absolutely required; others are inattentive, and the operators must use diligence and hasten them. The trouble comes, as *Falstaff* says, from "the disease of not listening, listening, the malady of not marking."

Hence, it is not to be wondered at that the operators are inclined to say as did *Olivia* to *Viola*, in "Twelfth Night," when he would deliver himself of his long sentences: "If you be not mad, be gone; if you have reason, be brief: 'tis not that time o' moon with me, to make one in so skipping a dialogue."

Electrical Notes.

The number of persons engaged in rediscovering old discoveries is really surprising. It is a singular fact that man, vain man, has such confidence in his own originality that he will toil and plod in secret over something that has been long before exploited, whereas had he made a few inquiries beforehand he had been saved a deal of unnecessary labor and a not inconsiderable amount of mortification.

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From time to time we hear of some poor fellow who is wasting the sunshine and burning the midnight oil over a device whereby he seeks to navigate the air on the bird theory, in the vain belief that no one has conceived the idea or, at least, made a practical application of it before his advent on the field.

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Now the news comes from California that a man named Lockwood is engaged in such an undertaking, and expending not only his own but other people's money in the endeavor to devise a contrivance similar to the bird's wing. So sure was he recently that he had accomplished this, that he essayed to fly from the roof of his barn, only succeeding, however, in being projected like a paper dart into a neighboring pig-sty, much to the surprise and consternation of its occupants.

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As a matter of fact the bird possesses far greater proportional strength for a particular purpose than man; exerted through a particular set of muscles, or, to be still more precise, of the total amount of vital energy of his system, the bird can use a far greater proportional part in the exercise of those muscles adapted to locomotion than man or any other vertebrate animal can do. In no other animal may be found muscles to compare in relative size to the breast muscles of the bird, consequently no such relative expenditure of the total energy of the system.

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But there is no reason to believe that ærial navigation is beyond the contrivance of human ingenuity, though ærial flight is.

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M. Tisandier, in France, is said to be making very encouraging progress, using gas as the agent of buoyancy, and electricity drawn from storage batteries from which to derive his locomotive power.

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Those who have visited the mines have, no doubt, observed how ineffectual the miners labor when attempting to obtain gold by amalgamation from ores containing arsenic and certain other impurities, the mercury "sickening" and failing to take up the gold. A method has recently been devised, however, of successfully accomplishing this. The inclined table over which the ore is washed contains hollows filled with mercury; over these, in the water containing the washings, copper wires are introduced, and brought so near that a powerful current may be passed to the mercury, which seems to gather itself away from the impurities, and to act more energetically upon the ore.

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In all professions there are quacks and charlatans, and that of the electrician is no exception to the rule.

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When the electrician was toiling in his workshop or laboratory, and striving meantime to keep the wolf away from the door, the name electrician was synonymous with honesty. But when the dull, heavy clouds that had hung so long over him began to break, and the bright blue of prosperity, begotten of success, became visible, the *soi disant* electrician left the purlieus of the stock market, and loomed up threateningly on the horizon.

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The game was to supply a promising but needy electrician with money enough to carry on his experiments, and then form a stock company, and without his sanction to promise results for his undertaking that he could not hope to realize.

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To say they played it well is but inadequately to express their success. Bonds which it would be but a perversion of the truth to call securities, found a ready sale, and things would run along smoothly until an inevitable investigation discovered the fact that the whole thing was a swindle, and that the originators of the scheme had long since unloaded and decamped. In vain the poor fellow at work in his workshop would protest that he knew nothing about the financial affairs of the company that had advertised his invention, further than through its agency money had been supplied him to continue his experiments. He was set down as a humbug and a fraud.

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Some time since, a well-known electrician told me of an experience he had had in many respects similar to the above. He discovered a means of alleviating certain disorders by means of the application of electricity. Not having the time nor the inclination to make a practical use of the discovery, he contented himself with applying it to those of his friends who happened to suffer from the ailment which it had been found to affect.

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One day, while the electrician was at work in his laboratory, there arrived in town a stranger, with a somewhat attenuated figure, a carpet-bag of proportions by no means robust, and a nerve that the broadside of a man-of-war couldn't shake.

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His clothes, no two articles of which were of the same color, appeared to have been purchased and put on but a few hours before, a fact more directly established by the clothes dealer's ticket, which still adhered to his coat collar, giving the number, size and general dimensions of the garments, somewhat obtrusively, to an uninterested public. His trousers had a straight line in them, as though he had been born flat, but had since developed, and there was another crease down his back, like the figures children cut out of folded paper.

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At first he was set down as a bank-robber, and the villagers, hastily locking up their valuables, loaded their guns and looked out in expectancy from their second-story windows.

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It was all a mistake, however. The stranger had come from distant parts to enter into negotiations for the purchase of the curative discovery of the electrician.

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"I told him distinctly," said the latter, subsequently, "that it wouldn't cure anything; it would alleviate, or temporarily relieve persons afflicted with certain disorders, and that, if I sold it to him, it was upon the understanding that he should not use my name in connection with it. To this he consented."

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Nevertheless, the remedy in question was soon advertised far and wide, with the electrician's name attached, as a sure curative for all the ills to which humanity is heir with the possible exception of inebriety, against which the normal condition of the proprietor was good circumstantial evidence that it was impotent.

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Dr. Siemens, Dr. Frankland and Dr. Gladstone, all practical electricians' are at loggerheads concerning the uses to which the storage battery may be put. When doctors disagree, it would seem, to use an expressive but inelegant phrase, to be "a cold day" for the laymen. Nevertheless, the latter, who are apt to place a full valuation on their own abilities, are going ahead with their work as though all the authorities were with them.

In a recent lecture on "The Electrical Transmission and Storage of Power," Dr. Siemens expressed the opinion that the electric system of propulsion was sufficiently advanced to assure practical success under suitable circumstances, such as for suburban tramways, elevated lines, and, above all, for lines through tunnels. As to secondary batteries, he said that a fear had been expressed by many that local action would soon destroy the fabric of which they were composed, and that the active surfaces would become so coated with sulphate of lead as to prevent further action.

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It has been demonstrated, however, as opposed to this, by Dr. Frankland, corroborated by Dr. Gladstone and Mr. Tribe, that the action of the secondary battery depends essentially upon the alternate composition and decomposition of sulphate of lead, which would seem, therefore, instead of an enemy, the best friend to its cantinuous action.

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The various telephone companies under Lowell management, handled in March 22,618 ex-territorial messages, as follows: Maine, 1,761; Boston and Northern, 12,574; an increase of 1,757 messages. Bay State, 8,279, an increase of 1,367 messages This is the largest month's business ever transacted.

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ALBANY.—Mr. Daly's bill requiring the sinking below ground of telegraph, telephone, and electric light wires in New York City, after laying in the hands of the Assembly Committee on Cities for weeks, was finally reported and passed the Assembly on the 12th inst. As amended, the bill is made to apply to telegraph lines only. Telephone and electric light wires are allowed to run above ground, as at present. Mr. E. A. Maher, a member of the Cities' Committee, according to the *Evening Journal* Almanac, is "manager of the Albany Electric Illuminating Company." The bill was also amended by striking out the provision inserted in it which provides that the companies shall pay the expense of removing the poles, thus throwing the burden upon the city instead of upon the corporations.

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The *Engineer* (London) says that the effect on plants and shrubs of the products of combustion of gas is showing itself already at the Crystal Palace Exhibition. An enormous quantity of gas is being burnt in parts of the nave, and the big lamps are closely spaced. Yet there is an absence of what may be called an atmosphere of light, which is observable where the electric arc lights are used, though they are much fewer in number.

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H. E. Bassett, night manager at the telephone office at New Haven, has tendered his resignation. Faithfulness and readiness to oblige are characteristics which everybody who has had occasion to use the wires between early bed-time and the breakfast hour have found him to possess.

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There were 41 electric lights lighted in Fall River, Saturday night, the 14th inst., by the Fall River Electric Lighting Company, located in different parts of the city. About 20 more will, it is expected, be put on during the present week by the company to other subscribers.

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The effects of lighting up aquaria by Mr. E. G. Blackford with submerged electric burners may present some items of interest. It is quite possible that experiments of this character, on a much more extended scale, will be tried by the United States Fish Commission in their sea work. By making use of submerged electric lights, they hope to attract fish at sea, and thus determine their presence. It looks as if the fact was well known by primitive man that fish were attracted by light, and the fishing races of Australia use fires in their canoes. In the aquaria in Fulton Market, when the current was turned on at first, the two large rainbow trout were sensibly affected, and made some disturbance, but after a while took little notice of it. The brook trout were, however, more or less lively during the whole of the time the lights were on. Mr. Blackford thought that when a number of fish were in an aquarium the heat absorbed by the water would cause a sufficient rise of temperature as to be prejudicial to the fish. In a large tank, however, with a few fish, no such trouble would exist. As it is, this electric lighting may be the best method of exhibiting fish in aquaria, though what Mr. Saville Kent, the best authority on such subjects, has to say may yet be expected.

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It is understood that a rival electric lighting company will be established at Providence, R. I., at an early day. Mr. Edward H. Goff, President of the American Electric and Illuminating Company of Boston, has looked the field over carefully and proposes to organize a company with the most perfect electric light equipments, and which, it is said, will overcome some of the prejudices that have been created in this city against this kind of illumination by the unsteady and unreliable light of the company doing business here at present.

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Mr. Jay Gould advertises that, in view of the serious inconvenience to many persons from suits against the Western Union Telegraph Company, he has arranged with the Mercantile Trust Company to advance to all stockholders of the Western Union on and after April 12, 1883, the amount of their dividends payable April 16, 1883, upon assignment to him at the office of said Trust Company of their right to receive the same. The portion of the January dividend still unpaid will be arranged for in the same manner.

Questionable Business Methods.

In our issue of April 5th, under the title, "Electrical Bubbles," we took occasion to warn our patrons against a class of companies which, if not absolutely bogus, are, at least, not strictly legitimate. We said, speaking of such companies: "We have a list of these now before us, and shall, at a no distant day, tear off the lambs' skins by which they are covered, and exhibit to the light of day the true nature of the animals beneath."

We were at that very time investigating the case of a company in Boston, Mass., and the investigation having confirmed our suspicions that its business was not conducted in accordance with strict legitimate methods, we are compelled, in justice to our patrons, whose interests it is our bounden duty to protect, to warn them.

We do not wish to be understood as characterizing "The Portable Electric Light Company" of Boston a swindle. We have never heard of their accepting money and not giving anything in return. But we claim that this company encourages people in the belief that it has a portable electric light, and when they send in their money they get a little apparatus of questionable value that will emit a spark which might possibly light a gas and save matches, and that is about all. Again, we claim that since this company has no portable electric light, the name "Portable Electric Light Company" is a misnomer calculated to deceive.

In all this we are sustained by Postmaster-General Gresham at Washington (as will be seen by the following dispatch from the Associated Press), who for several reasons has placed the name of this company on the black-list.

As we said before, we have refused longer to find a place for the advertisement of this company in our columns, and we hereby notify all dealers in electric goods of questionable integrity that they only waste time in sending in their advertisements to us. Nor is it, as some of these gentry are disposed to think, a mere question of money. Should they offer us ten times our usual advertising rates, we will not find a place for their announcements.

The ELECTRICAL REVIEW has been generously supported, not only in this country, but all over the continent of Europe, and even in remoter lands.

The very strength of the journal lies in its integrity, and in the fact that its patrons have entire confidence in its columns.

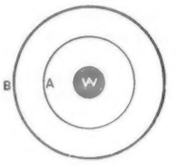
On the 11th inst., Postmaster-General Gresham placed the Portable Electric Light Company, of Boston, on the department black list, and directed that money orders and registered letters be withheld from the company. This concern advertised portable machines for $5, which would furnish instantaneous light, and could be placed upon desks or tables. The light is only useful to light cigars or lamps, and cannot be used for general illumination purposes, as intimated in some of their circulars and advertisements.

April 13, 1883.

To the Editor of the Electrical Review:

The article of T. D. L., in your issue of April 12, would, under ordinary circumstances, not be worthy of notice; but as the gentleman has not informed himself, in his "exhaustive search," of the extent of confirmation of the claims made for the Spiral wire for telephone use, by calling at this office, but two blocks from his own; and as he is *incapable* of explaining the causes for the improvement so much needed, I shall be pleased to enlighten him.

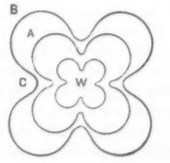
The first line of spiral wire was strung four months ago, surrounded by many other wires over which *very bad induction exists.* This company has ample affidavits of the superiority of its wire as a talking wire, and



one which neither induces nor allows induction. A second and third line, of four to five miles each, was then strung, and a third added (21 miles), with better confirmation of the claims on the longer lines, and this company is now filling its eleventh order for a sixty mile wire, the previous lines being 26, 10, 5, 16, 12, 5, 5, 1½, 1, 2 miles.

The results obtained, as compared with those observed with common round wire, *are not understood by electricians,* and, but for the letter of T. D. L., would not have been explained at present, as I am a believer in *practical* rather than *theoretical* work, but he shall be enlightened. The improvement noted in spiral wire may be attributed to a different distribution of electricity upon the different shapes. In the round wire the strength of its induction is uniform at uniform distances from it, and is represented by concentric circles, thus:

W representing the cross section; the induction field about it will be as represented at *A* or *B*, in which the circles represent the relation between *W*, and what it can do at a distance *W*, *A*. If another conductor is placed at *A*, the inductive effect it would be subject to, would be the same anywhere in that circle, and the same condition would apply at *B*. This is not the case if the wire is *spiral*.



Where the body *C* may be much nearer to *W* than *A* or *B*, and yet not be affected by induction from *W*, as it would be at either of those other places, and as such a field as the latter is more stable than the uniform one, inductive action is less on adjacent conductors than on common round wire. The effect of the spiral form on adjacent conductors is to bring the latter into fields of different strength; thus, if the conductor was at *C* in the diagram, and was stationary, and *W* should turn so as to bring the part of the field *A* about *C*, then there would be an electric disturbance in *C*, which would start to the ground. As this is repeated in the spiral wire, the resultant of all being the neutralization of all inductive currents, and the longer the wire the freer it is from induction.

The gentleman will pardon me for suggesting that it seems that he or some of his friends seem to "greatly fear that the advantages which have been enumerated" do "exist." The gentleman endeavors to disclaim any slanderous intent, and acknowledges the wire as good as the ordinary line wire; but he attempts to intimidate and cautions buyers "against paying any advance over the retail price of galvanized iron wire of the same gauge," which seems rather "absurd," when the little spiral wire of this company weighs less than half that of common wires. His "eyes are now open," I trust, to the unnecessary "caution" with which he has so officiously bedaubed the public, who will best judge for itself of the prospective value of the American Spiral Telephone Wire Company stock.

GORHAM GRAY,
43 Milk street, Boston, Mass.

Cables in the Streets.

THE ELECTRIC LINES COMPANY.

The system of the Electric Lines Company, whose franchise was passed by the Board of Aldermen over the Mayor's veto on the 11th inst., may briefly be described as follows:

Instead of being an iron pipe to contain electric wires, a wooden box nineteen inches wide and seven inches high, divided into three compartments, is employed. Each compartment will contain one cable of sixty-eight wires. The method of forming the cables aims at economy and prevention of induction from the earth, the chief trouble with all earth cables. The wires are strung upon gutta-percha templets, which hold them apart, and when all are in place the templets are so moved that the wires are twisted in opposite directions instead of remaining parallel, a device by which induction will be lessened. Then a mould is placed around the cable of naked wires, and filled with a melted insulating material, of which paraffine is the chief ingredient. When the mixture cools and hardens, the moulds are removed and the cable laid in its box, in lengths of 400 feet. At every street corner is a service box where connections can be made from one wire to another. The trench will thus contain 204 wires, which will be offered at fixed rentals to persons or companies requiring them for electric service—telephone or telegraphic. No electric light wires will be admitted to the cable-boxes on account of the powerful currents used, but some provision may be made for them in the same trench.

Mr. S. H. Shelbourne, the President of company, said to a reporter of the *Evening Post*, that the boxes will be laid two feet below ground and the work will be carried on at the rate of a block a day. The city will be paid two per cent. on the gross receipts of the company. The expectation of the promoters of the enterprise is that they will be able to furnish wires at less than the present cost of stringing them over the tops of the houses. If the use of call instruments and telephones goes on increasing at the present rate, telephones will be as common in New York houses when the Bell patents run out, as running water now is, and as it will be out of the question to allow thousands of necessary wires for such a service to be carried over the housetops or upon poles, a system of cables will be required. According to the officers of the company, the work will begin next month, and the cables will be laid in the chief thoroughfares of the city, so that any building in New York may be connected with any other building at small expense.

The officers of the company are: Sidney F. Shelbourne, President; George L. Weed,

Vice-President and Treasurer; Herbert P. Brush, Secretary; Stephen Chester, Electrician, and Edward Barr, Supply Agent.

Our esteemed contemporary, the *Evening Post*, remarks as follows concerning the granting of the above franchise, and we shall in a future edition have something to say on this question:

"The Board of Aldermen having passed over the Mayor's veto the resolution or ordinance granting to the Electric Lines Company the right to open the streets for the purpose of laying tubes for the conveyance of electric wires under ground, we are compelled to treat the measure as an accomplished fact so far as the city government is concerned. The resolution and the manner of its passage bear all the outward marks of rescality, and, if it were a subject still open to debate, we should insist upon guarantees even more stringent than those suggested by Mayor Edson in his veto message. Nevertheless, the project looks toward answering a great public need, and it is possible that some advantage may grow out of it corresponding to the public inconvenience of having the streets again torn up. The right to put wires under ground had been previously granted to three companies which are now using electric wires on poles, but these companies appear to be in no haste to avail themselves of their privileges. If the privilege granted to the Electric Lines Company shall have the effect to cause the others to bestir themselves, it will prove of some indirect benefit to the community."

Inventions of the Future.

HOW THE TELEPHONE WILL BE MADE A FAMILY BLESSING.

"What more can be invented?" asked an enthusiastic citizen on Saturday, after listening to the talk over the line from here to New York.

"Why, we have only begun," replied a gentleman who had paid some attention to the subject. "To talk six hundred miles or so is nothing. Why, you just wait ten years, and I will tell you what you will see."

"Well, let's hear you now."

"In the first place, the present Morse system of telegraph will have entirely passed away. Talking will be so much more rapid and accurate."

"Yes, I admit that."

"Well, that is not all. There will be a perfect network of telephone communication, and it will be very cheap. But that will not be all. By the payment of a very small sum the father in northern Ohio can step to the telephone station at the township center and call up his married daughter, who many years ago emigrated to Dakota. As he talks he will look into a finely-adjusted mirror that stands before his face, and in that mirror he can see the face of his beloved daughter as she talks to him. She, at her end of the line, of course, will observe the countenance clearly and distinctly also. The conversation will run something like this:

"You seem to be a little pale to-day, father. Are you as well as usual?"

"Why, yes, I guess I am all right. How are the babies?"

"Oh, Sally was sick all night and don't seem to be just right this morning. Here she is (holding her up to the telephone). You must excuse her appearance. Her face is not very clean; I have been so busy that I have not had time to wash it, and she has been playing around and got this apron very dirty, too."

"'Sally is all right, ain't she, little one? Her grandpa does wish he could take her in his arms. He can see her very clearly, though. I think she grows more like her mother's folks as she grows older. Don't you?'

"'Yes, we all agree on that; William has insisted almost ever since she was born that she was mother's girl. But here is Henry and John; both want to see and talk with grandpa a minute this morning.'

"'Bless their souls, grandpa wants to see them, too. Let them come to the 'phone.'

"And so the conversation will go on, and all for ten cents."

The forthcoming week promises a lively discussion in the Legislature concerning the bill calling for the removal of telegraph and telephone poles from the streets. An electrician connected with the local telephonic systems said, concerning the proposed action of the Assembly Committee on Cities in exempting telephones from the provisions of the "Underground Bill," that the fact has been demonstrated before the committee that in the present state of the art underground telephoning is an impossibility, except through the construction of tunnels (like the sewers of Paris), the cost of which would so increase the expense of operation as to make it practically prohibitory. . The recent successful experiments in long-distance telephoning have brought into prominence the telephone as a possible competitor to the existing telephone monopolies. The general public are but little aware of the magnitude already assumed by this branch of the business. The telephonic system of New York City, aggregating over thirty thousand miles of wire (more than double the entire underground telegraphic system of the German Empire), is now connected with upward of two hundred places within fifty miles of this city, and messages to the number of thirty thousand are received and forwarded each month. The proposed underground system in New York City would act like a Chinese Wall, shutting out the contiguous territory and the great possibilities of the future growth of the business. It would be far cheaper if we could run our wires underground, but it is impossible. We have been experimenting for years in the matter. There is more retardation in sending a message from this city to Jersey City under the Hudson than there is in sending a message overhead to Cleveland, Ohio, a distance of 750 miles."

NEW PATENTS—ELECTRICAL—1883.

INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING MARCH 27, 1883.

274,632 Apparatus for electric telegraphy; Pedro Enrique Perez, New York.

274,602 Circuit for telephone exchanges; Angus S. Hibbard, Milwaukee, Wis.

274,611 Conduit for electric wires; William H. Johnstone, Philadelphia, Pa.

274,710 Conduit for telegraph and telephone lines; Simon Brentano, New York.

274,573 Electric bell; Constant François de Redon, Paris, France.

274,699 Electrical conductor; George F. Barker, Philadelphia, Pa.

274,744 Electric arc lamp; James Du Shane, South Bend, Ind.

274,821 Electric wire insulator; William H. Reiff, Philadelphia, Pa.

274,865 Electric generator; Samuel J. Wallace, Keokuk, Iowa.

274,622 Insulating compound for electrical wires; John F. Martin, Chicago, Ill.

274,654 Incandescent electric lamp; Charles G. Perkins, Camden, N. J.

274,845 Insulated wire for electrical purposes; Frank H. Thompson, Waterbury, Conn.

274,564 Lightning conductor; Jas. H. Coon, Des Moines, Iowa.

274,818 Motor for drawing wires through tubes; Wm. J. Philips and George L. Kitson, Philadelphia, Pa.

274,552 Pole changer for telephone call circuits; Edward E. Bawsel, Washington, D. C.

274,665 Printing telegraph; George B. Scott, Brooklyn, N. Y.

274,748 Printing telegraph; Stephen D. Field, New York.

274,653 Switch for incandescent electric lamps; Chas. G. Perkins, Camden, N. J.

274,802 Secondary battery; Abram J. Martin, Catskill, N. Y.

274,576 Transmitting telephone; Thos. A. Edison, Menlo Park, N. J.

274,577 Telephone; Thos. A. Edison, Menlo Park, N. J.

274,857 Telephone exchange signaling circuit and apparatus; Theodore N. Vail, Boston, Mass.

274,522 Underground telegraph wire conduit; Alexander Sloan, Newark, N. J.

A printed copy of the specification and drawing of any patent to the annexed list, also of any patent issued since 1865, will be furnished by any of the patent solicitors whose advertisements appear in this journal. In ordering please state the number and date of the patent desired.

Manufacturing News.

New Manufactories, Extensions, Alterations, Additions, Etc.

The new Kelly nail mill, at Trenton, is going up rapidly; sixty men are at work, and the foundations are progressing rapidly.

The Mississippi Glass Works Company, of St. Louis, are now running both their furnaces with gas, which gives great satisfaction.

It is said that there is no country in the world that equals Mexico in the abundance and variety of fibrous plants which can be utilized in paper making.

The new Paige Car Wheel Company, of Springfield, Mass., will remove to Cleveland shortly. The new shops in Cleveland are almost completed, and are 50x100 feet, three stories high.

The St. Louis Bolt and Iron Company will have in their new mill two Siemens heating furnaces and eight gas producers, which will be built for them by the St. Louis furnace-Building and Construction Company.

Toledo's new iron plant, the Licking Rolling Mills, will be rapidly pushed forward with the opening of spring. Large quantities of timber and building material have been delivered, and contracts for the new buildings let.

Two additional wire mills, to make wire rods and fence wire, are to be erected at Chicago during the season. One of them will be located near the Calumet Iron and Steel Company's works at Cummings, and the best and most approved modern appliances are to be adopted.

Chicago has 266 establishments engaged in the manufacture of iron, of which 8 are barbed-wire works, 15 wire works and wire-cloth works, 28 machinery manufactories, and 4 car-wheel works. Capital invested is $17,400,000; workmen engaged, 18,600; value of product, $45,255,000.

There are produced annually in North America 100,000 barrels of hemlock bark extract, of which a single Boston firm produces 72,000 barrels. They own nine extract works and operate twenty-three tanneries. All the tanneries of the United States consume annually 1,250,000 cords of hemlock bark, produced in nine States. As the yield of bark is about seven cords to an acre of hemlock timber, the yearly consumption implies the clearing of 178,000 acres.

The American Steamship Company has been incorporated mainly by New York capitalists to build iron steamships. Ex-Lieutenant Commander Gorringe, will be manager of the works, which are to be in Philadelphia. The old shipyard of the Reading Railroad Company, at Port Richmond, has been leased and buildings are now being erected to contain the machinery. In a week or two the building of ships will commence. Mr. Gorringe's headquarters will be in New York.

A short time ago a collection of surgical instruments was dug up at Pompeii. It was evidently the property of some single establishment and was quite elaborate. The "find" was removed to the Naples Museum. One of the appliances attracted great attention. It was a long rod with a metallic plate fixed at one end at an angle of 135 degrees. At first it was thought to be a cautery for internal operations, but its resemblance to the modern laryngeal mirror suggests the probability that it was so used.

New Companies.

The following new companies were licensed, incorporated or organized last week: The McTighe Electric Light & Manufacturing Company, of Pittsburgh, Pa, capital, $300,000; the Garden City Electric Light Company, of Chicago, capital $1,000,000; Chicago Electric Light and Power Company, capital $1,000,000; the Galesburg (Ill.) Edison Light Association, capital $25,000; and the Indianapolis (Ind.) Parker Electric Light Company, capital $100,000.

Business Notices.

The attention of persons interested in local telegraph and telephone organizations is respectfully called to the electric lighting system of The Fuller Electrical Company, and the practicability of making arrangements with that company for the introduction of its apparatus, either in isolated plants, or through the formation of local companies desiring to engage in the business of electric lighting. The specially valuable feature of this company's system may be seen by examination of its apparatus in Boston, Worcester, Providence, Hartford, New York City, Brooklyn, Jersey City, Paterson, Philadelphia, Lancaster, Scranton, Syracuse, Rochester, Buffalo, Pittsburgh, Wheeling, Steubenville, Xenia, Dayton, Grand Rapids, Chicago, Springfield, Belleville, St. Louis, St. Paul, and many other smaller places throughout the country. Correspondence is invited.

THE FULLER ELECTRICAL COMPANY,
44 East 14th Street, New York City.

A Dictionary of Electricity, by Henry Greer, N. Y., Agent College of Electrical Engineering, 122 East 26th street, New York. Octavo, $2.00. Professor Edison says of it: "It is exceedingly valuable to all interested in electrical science. Leaving out frictional electricity and inserting cuts and descriptions of the recent wonderful inventions, makes it exceptionally interesting to electricians and telegraphers. Nearly every electrical inventor and manufacturer in the world will find a description of their invention or apparatus in it."

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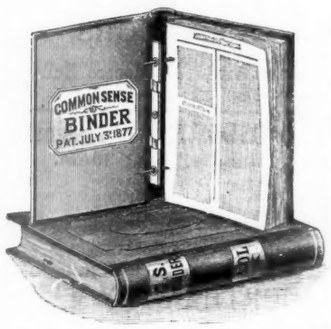

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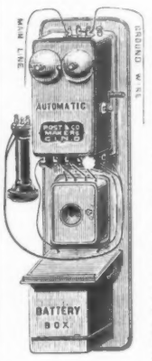

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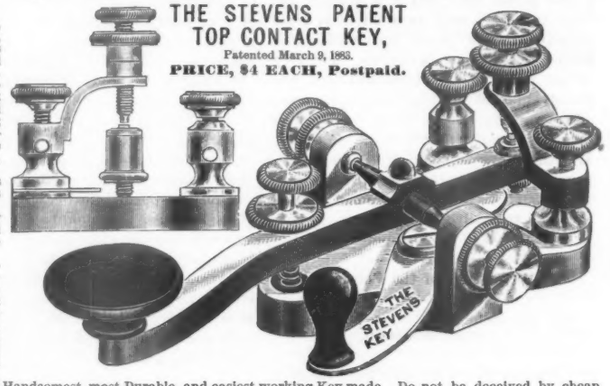

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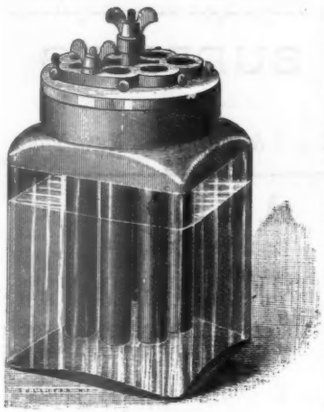

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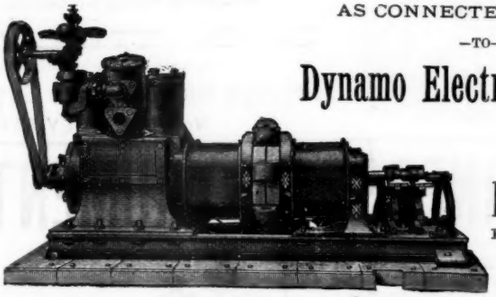

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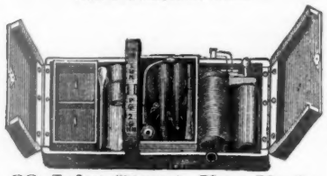

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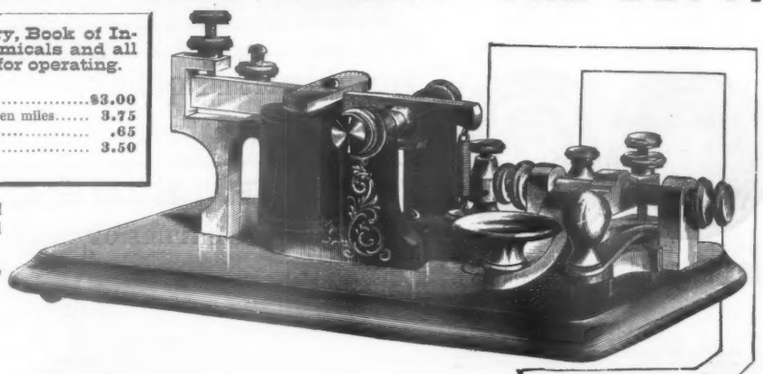

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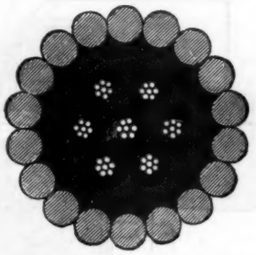

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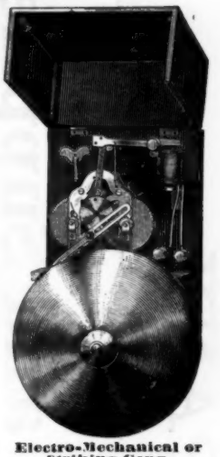

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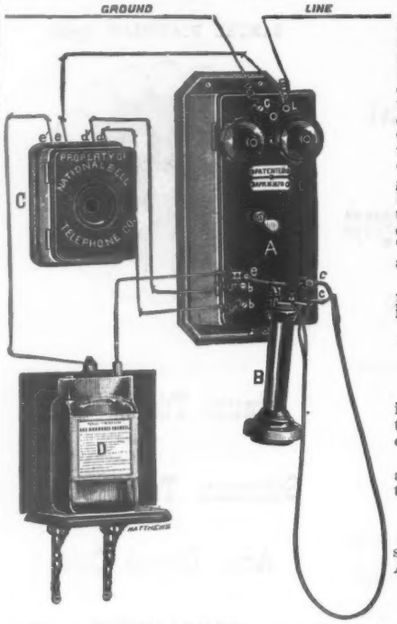

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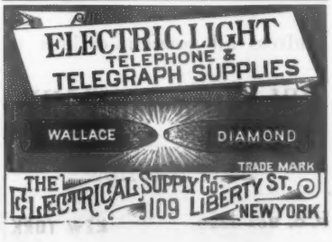
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